Adaptation and application of the QSTEMHE questionnaire on gender stereotypes in STEM studies to the Brazilian context

Maura Angelica Milfont Shzu[1*], Sonia Verdugo-Castro[2] and Alicia García-Holgado[3]

[1] *Faculty of Science and Engineering Technologies, FCTE, University of Brasília, Brazil*

[2] *GRIAL Research Group, Dpt. of Didactics, Organization and Research Methods, University of Salamanca, Salamanca, Spain*

3 GRIAL Research Group, Research Institute for Educational Sciences, University of Salamanca, Salamanca, Spain

Abstract

The gender gap in STEM fields (science, technology, engineering, and mathematics) is a global issue that affects not only the active and full participation of women but also social justice. In today's globalized world, where technology has permeated all areas of knowledge, it is urgent and necessary to strive for gender balance in every field to ensure the democratization of social benefits. All changes generate resistance, whether from agents who enjoy the privileges provided by a social structure with patriarchal influences, or from the class of people who are on the margins of society and accept the system due to cultural reasons. Brazil is one of the most unequal countries in the world, and the gender debate still faces many barriers. Understanding how people perceive gender-related issues is the first step toward building effective actions in favor of equity. This article aims to validate the QSTEMHE opinion instrument among university students regarding higher education in science, technology, engineering, and mathematics (STEM), initially designed for application in Spain. The questionnaire, distributed nationally, gathered a sample of 1,298 Brazilian higher education students. The adaptation to the language and context was carried out by a Brazilian individual and underwent a linguistic evaluation, considering the specific educational and cultural context. In the validation study, the questionnaire achieved theoretical construct coherence, a high correlation between the items, and the expected reliability for continued analysis.

Keywords

STEM, gender gap, questionnare, university students, Brazil

1. Introduction

The participatory inequality between men and women in society is a threat to sustainable economic development and the well-being of all citizens. Removing the barriers that hinder the promotion of diversity in the workplace is, therefore, an urgent and necessary task. Thus, investigating the factors that lead women to distance themselves from STEM careers is the first

Proceedings XVI Congress of Latin American Women in Computing 2024, August 12–16, 2024, Bahía Blanca, Argentina.

* Corresponding author.
† These authors contributed equally.
maura@unb.br (M.A.M. Shzu); soniavercas@usal.es (S. Verdugo-Castro); aliciagh@usal.es (A. García-Holgado)
0000-0002-5636-3623 (M.A.M. Shzu); 0000-0002-9357-1747 (S. Verdugo-Castro); 0000-0001-9663-1103 (A. García-Holgado)

© 2024 Copyright for this paper by its authors. Use permitted under Creative Commons License Attribution 4.0 International (CC BY 4.0).

CEUR-WS.org/Vol-3872/paper1.pdf

CEUR Workshop Proceedings ceur-ws.org ISSN 1613-0073

step in seeking effective solutions to minimize this issue, which, in addition to impacting social justice, also jeopardizes human relations across all social strata.

Thus, the QSTEMHE opinion research instrument [1], designed by [2,3] to analyze the gender gap in STEM fields (Science, Technology, Engineering, and Mathematics) in Spain, was translated and adapted to Brazil with the same objective [4]. The questionnaire was designed for a descriptive cross-sectional study focusing on gender, perception and self-perception, interest, attitude, and expectations related to science. It is a quantitative instrument that includes a set of open-ended questions allowing for qualitative analysis. For the validation, closed-ended items were considered, specifically, 18 sociodemographic questions and 24 Likert-scale items where respondents indicate their agreement or disagreement [5]. The responses are measured on a 4-point scale: 1 being Totally disagree, 2 Disagree, 3 Agree, and 4 Totally agree. Additionally, there are 5 questions to capture the participants' environment.

Considering that the diversity between the two countries affects both language use and the way a population group perceives and interprets the world, a validation study of the new instrument is necessary. This procedure ensures the integrity and relevance of the instrument in light of the cultural differences that define a nation. Furthermore, it opens up several possibilities, such as analyzing the Brazilian profile on issues related to STEM fields and the gender gap problem, conducting a comparative study between Brazil and Spain, reflecting on the various topics addressed by the questionnaire, and, once the influencing factors governing the issues have been understood, proposing more effective solutions for gender equality in STEM.

The factors that determine how individuals perceive themselves in STEM fields, for example, are diverse and accompany them from their earliest life experiences. Carroll et al. [6] highlighted that young people aged 16-18 from economically disadvantaged families with lower educational attainment tend to have lower expectations of success in STEM fields, regardless of gender. When it comes to women, cultural effects are added, as gender stereotypes reinforce the social perception that competitive fields do not align with their nature. Given the diversity of social profiles in Brazil, the sample collected through the analyzed instrument represents a privileged and small segment of the country, as they have gained access to higher education. Despite having the fourth-largest education system in the world, Brazil still graduates relatively few individuals at the higher education level compared to other countries [7]. In 2022, only 23.4% of Brazilians aged 25-34 had a higher education degree, a figure still significantly below the OECD average of 46.9%. Spain, on the other hand, surpassed this mark with a percentage of 48.7% [8].

Access to higher education in Brazil grants individuals social status, due to the prospect of entering the labor market. The employment rate among people aged 25 to 34 with higher education increases by 86%. For comparison, the income ratio between workers (aged 25 to 64) with higher education and those with secondary education in Brazil in 2021 is 2.5, while in Spain it is 1.5 [9]. However, the various factors contributing to the gender gap in STEM fields and the difficulty women face in achieving full development in these areas place them among the population group that receives the lowest salaries [10].

Measures to promote gender equity in Brazil are still insufficient. Many factors contribute to the persistence of gender inequality, such as the organizational structure of society [11]. On the other hand, it must be acknowledged that there have been advances, despite the country still scoring high in terms of gender inequality. Brazil ranks 57th in the 2023 Global Gender Gap

Index, out of 157 countries. Spain is in a better position, ranking 18th. Among the 21 Latin American countries, Brazil is ranked 14th [10]. While Brazilian women make up the majority of university graduates, 60.8%, their participation in STEM fields is still very low. In engineering, manufacturing, and construction, as well as in computing and information and communication technologies (ICT), they represented only 35.1% and 15.3%, respectively, in Brazil. In the fields of Natural Sciences, Mathematics, and Statistics, women had a slight advantage with 53.1% participation [12].

Gender equality in STEM fields is an urgent and necessary goal, especially in a context where technological advancements are rapidly evolving. Brazil has a long road to evolution in this direction. The difficulties in implementing even digital inclusion and quality basic education for all through gender equality initiatives. The immense social inequality, which prevents the full development of a large percentage of its youth, reinforces the privileges of a society that has yet to free itself from the exclusionary legacies of its colonization.

Understanding how 21st-century youth perceive or self-perceive themselves in STEM fields, considering their social and family context, is essential to fostering discussions on gender equality, especially because it sheds light on an issue that has long been overlooked or obscured by pseudosciences that link vocation to gender.

Thus, the QSTEMHE questionnaire adapted for Brazil undergoes validation procedures where the concordance of its content with the theoretical construct established by [2,3,13], the correlation between the items and the reliability of the instrument are analyzed. The items presented, among them, high correlations, with adequate framework in their theoretical constructs. Each of the dimensions allowed obtaining the expected results, coinciding with the results obtained in Spain. In addition, the instrument presented a reliability indicator above 70%, indicating the convenience of the continuity of the analyses.

In order to address the validation, the present work has been organized into five sections. The second section describes the methodology used to carry out the validation in the Brazilian context. The third section presents the descriptive analysis of the sample obtained. The fourth section performs the analysis of the case study carried out. And finally, the last section describes the main conclusions of the study.

2. Methodology

Before the dissemination of the opinion questionnaire, the QSTEMHE was translated publicly and certified, with recognition by the District Federal Board of Trade and formally registered under No. 1453, Book No. 16, Sheet No. 10. The questionnaire was submitted to the Ethics Committee of CEP/CHS at the University of Brasília, whose certification for the presentation of ethical review number 58603420.8.0000.5540 was approved with the opinion number 5.908.089. The questionnaire underwent a linguistic evaluation and, regarding the format of the questions, the authors took into account the specific educational and cultural context of Brazil, incorporating changes mainly in the sociodemographic questions, and replacing certain terms or concepts to ensure proper understanding. The changes were supervised by the Spanish team in order to ensure construct validity, and they were also reviewed by several individuals of Brazilian origin.

The instrument is an opinion questionnaire, in which respondents participate anonymously [4]. An age exclusion criterion was applied, targeting individuals over 18 years of age who were currently attending or had recently completed their studies at higher education institutions in Brazil, whether public or private, in any field of knowledge. It is important to note that Brazilian higher education institutions award intermediate degrees—undergraduate (including technical studies) and postgraduate degrees (specializations, advanced studies, master's, and doctorates)—so no exclusion criteria were applied regarding the students' academic level.

For dissemination throughout Brazilian territory, the provisions of Resolution 510 of 07/04/2016, Article 1, Sole Paragraph, Items I and V, were considered [14]. The questionnaire was distributed electronically between May and September 2023, with the cooperation of various sectors of Brazilian higher education institutions and also with the help of respondents, who were able to share it with others in their network, thus forming a simple random probabilistic sampling method known as snowball sampling.

A sample of 1,298 respondents was obtained, and its representativeness and diversity were verified through a descriptive analysis presented in Item III. Excel software was used for data coding. Statistical analysis was performed using JASP, version 18.1, an open-access statistical analysis platform supported by the University of Amsterdam. IBM SPSS Statistics 28 was also used (licensed by the University of Salamanca).

The analyzed model is first-order and preserved the five dimensions established by [2,3] for the validation of the original theoretical framework. These are: Interest (INT), Perception and Self-Perception (PAP), Gender Ideology (GI), Attitudes (AC), and Expectations about Science (EXC).

These dimensions and their associations are explored in order to validate the instrument after its translation and application in Brazil. As a result of the validation, correlations between different items and between the factors themselves are also verified. The verification of the assumptions inherent to each variable, followed by factor extractions and rotations, model adjustment, and the final model, are part of the Exploratory and Confirmatory Factor Analysis, which form the theoretical path for the certification of the new construct.

It is important to emphasize that the final model is ratified by the Confirmatory Factor Analysis, which, as the name suggests, is conducted to confirm whether the model aligns with the theoretical construct [15].

3. Descriptive Analysis of the Sample

To evaluate the representativeness and diversity of the sampling, as well as to understand the data obtained, it is necessary to know the profile of the respondents. Among the higher education students surveyed in Brazil, 43.53% are men and 54.54% are women, 0.85% preferred not to answer, and 1.08% identified as non-binary. This is a relatively balanced sample in terms of gender. The vast majority of respondents were born in Brazil, 98%. Regarding race, 58.9% consider themselves white, 29.12% mixed-race, 9.48% Black, 1.70% Asian, and 0.8% Indigenous.

Most respondents live in urban areas, 91.76%, with 4.93% living in intermediate zones and 2.85% in rural areas. Although the definition of these zones is somewhat complex in Brazil, only 0.46% reported being unable to define the area they live in. While Spain classifies these areas by population size [16], in Brazil, the classification is based on functional size, urbanization, functional specialization, accessibility, concentration and diversification associated with industrialization, the predominance of the textile and food sectors, among others [17].

Of the total respondents, 51.31% are young people, according to the United Nations criteria [9], meaning they are between 18 and 24 years old, with 51.15% of the men and 50.71% of the women surveyed falling within this age group. Among all respondents, a larger percentage, 58.57%, are aged between 21 and 25 years, with 41.8% of men and 55.13% of women.

Of the total sample, 43.45% have completed at least one university course, with 41.13% of men and 57.62% of women distributed across this percentage. The percentages of respondents who have completed or are currently pursuing a bachelor's degree, master's, doctorate, and specialization are 64.22%, 17.66%, 14.42%, and 3.70%, respectively.

Analyzing by race those who have completed or are currently pursuing a bachelor's degree, 55.82% identify as white, 31.45% as mixed-race, 9.60% as Black, 1.92% as Asian, and 1.20% as Indigenous. Of those who have completed or are pursuing a master's, 64.19% identify as white, 26.64% as mixed-race, 7.86% as Black, 0.87% as Asian, and 0.44% as Indigenous. Of those who have completed or are pursuing a doctorate, 66.84% identify as white, 22.46% as mixed-race, 9.09% as Black, and 1.60% as Asian. These percentages reflect a national trend, although in unequal proportions. The National Council for Scientific and Technological Development (CNPq), in its latest statistical report on research groups, indicates that the presence of Black and mixed-race individuals decreases at higher levels of education. Although the quota policy in Brazil has facilitated the access of Black and mixed-race individuals to higher education, so much so that by 2017 they made up 48.45% of enrolled students, the DGP Census in 2023 recorded only 13.42% at the doctoral level. At this academic level, 75.23% are white, 1.25% are Asian, and 1.11% are Indigenous [19].

In Brazil, although the private network accounts for 78% of the higher education system [20], its communication channel for disseminating the research instrument proved to be less accessible, which explains why the majority of participants came from the public higher education network, 89.43%. Only 8.63% came from the private network, and 1.94% studied in both types of higher education institutions—public and private. Brazil has 2,595 higher education institutions, but only 296 of them are public [21].

Among all respondents, 35.62% studied at higher education institutions in the Southeast region, 23.07% in the South, 19.49% in the Northeast, 17.93% in the Center-West, 2.96% in the North, and 0.94% studied in institutions from more than one region, as shown in Figure 1. In Brazil, the Southeast region is the most populous and has the highest number of enrollments, followed by the Northeast (the second most populous region but with the lowest national enrollment rate per capita) and the South. The North region has the lowest number of enrollments [22].

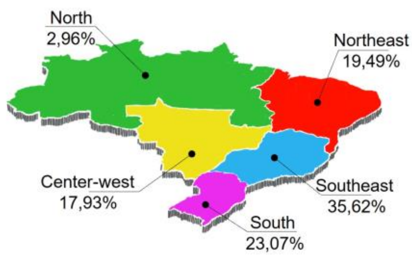

Figure 1: Percentage of surveyed students by geographic region. (Source: Own elaboration)

It was identified in the sampling that there was a balance in data collection regarding the fields of knowledge, with 43.74% of respondents coming from non-STEM areas and 56.26% from

STEM areas. In this sample, 69.04% of men and 45.9% of women are from STEM fields. Here, the imbalance in STEM areas, although not in the same proportion as what is known in Brazil, aligns with the country's and global trends, even though the gap between fields is greater than that observed in the collected sample.

The vast majority of respondents study or have studied their first-choice university course, 69.18%. Another 20.95% study or have studied their second choice. Of the total respondents, 84.75% expressed satisfaction with their study choices, with 45.03% from non-STEM courses and 54.97% from STEM courses.

Before entering university, 80.20% of respondents had an interest in STEM fields, including 85.84% of men and 76.13% of women. A total of 56.55% of respondents had participated in STEM activities, including 58.58% of men and 54.66% of women. A total of 27.73% of respondents had completed vocational training, of which 39.72% studied Engineering and Architecture, with 72.14% being men and 27.86% women; 22.22% studied Science fields, with 41.77% being men and 58.23% women; 14.17% studied Social and Legal Sciences, with 42% being men and 58% women; 12.50% studied Health Sciences, with 37.78% being men and 62.22% women; 11.39% studied Arts and Humanities, with 31.71% being men and 68.30% women.

Lastly, 32.67% of respondents were classified as coming from a middle socioeconomic background, 42.14% from a low to lower-middle background, and 23.65% from a high to upper-middle background. Of the parents with higher education, 44.53% are mothers and 36.13% are fathers. As shown, in the respondents' generation, women tend to have a higher level of education.

The descriptive statistics for each dimension showed means and standard deviations similar to those obtained by [2,3], as shown in Table 1, meaning that the response trends and variability corroborate their conclusions.

4. Data Analysis

The analysis of the data for instrument validation is an essential step in ensuring the reliability of the conclusions drawn. The study of correlations between variables, for example, is important as it allows us to verify whether the five dimensions of the theoretical construct created by [2,3] can also explain the proposed hypotheses when the evaluation instrument is the questionnaire adapted for Brazil. Although the items have been separated by dimensions, each explaining their corresponding proposed hypotheses, all the variables are also correlated with each other to a greater or lesser extent. This condition occurs when the data are not spherical. The Bartlett's test of sphericity is used to measure the correlation between the items, which is significant when its value is less than 0.05. For the studied sample, the p-value is equal to zero, thus confirming the expected condition of non-sphericity.

Table 1
Descriptive statistics of the representative variables of the dimensions

Dimensions	Average	Standard Deviation	Verdugo-Castro (2022)[14]	
			Average	Standard Deviation
D_IG	1,663	0,519	1,739	0,444
D_AC	1,482	0,56	1,554	0,526
D_INT	2,101	0,634	2,262	0,757
D_PAP	2,297	0,806	1,995	0,799
D_EXC	3,690	0,499	3,631	0,506

Source: Own elaboration

Partial correlations are evaluated using the Kaiser-Meyer-Olkin (KMO) test. The correlations among the items are sufficiently high, with a KMO result above 0.6 and an overall value of 0.818. These values indicate the appropriateness for continuing the analyses. Additionally, the p-value <0.001 obtained in the Bartlett's test of sphericity confirms the significance of these correlations..

To distribute the weights (factor loadings) of the items among the extracted factors, the oblique rotation technique OBLIMIN is used, as all items in this study are correlated [23]. This technique identifies the dimension of each item by maximizing the weight, as shown in Table 2. Thus, the extracted factors indicated that only two items did not fit within their theoretical constructs: items (27) and (37), which were therefore decided to be removed. The majority of the items have weights above 0.4 (17 out of 24 items) and maintained their placement in relation to the theoretical construct of [2,3,13].

After removing items (27) and (37) due to their low factor loadings, it was verified that the correlations between items remain sufficiently high. All KMO values are above 0.6, with a general KMO of 0.795. Although some items have weights below 0.4, they remain in the instrument because they provide coherence to the dimensions, and since this is an opinion questionnaire, greater variability in responses can be expected.

In Table 3, it is verified that the percentage of total variance explained by the model is 39.4%, which is adequate as it is explanatory of the model [24]. Additionally, the distribution of the percentage of variance among the rotated factors is shown to be equitable, varying between 0.071 and 0.086, again indicating that the model, with the five established dimensions, is satisfactory.

To measure the extent to which each dimension is able to explain the theoretical construct, the Average Extracted Variance was calculated. The five dimensions account for a percentage of variance that satisfactorily explains what they propose, with significant precision. The Interest dimension presented a slightly lower weight, but it is very close to what is acceptable. The Average Extracted Variance is equal to the sum of the squares of all the standardized coefficients divided by the number of indicators in the domain.

Table 2
Rotated Component Matrix

Dim.	Items											
	24	25	27	33	34	26	28	29	35	37	38	39
INT	0,132	0,136	0,073	-0,007	-0,010	-0,069	0,056	0,132	-0,015	0,515	0,188	0,497
PAP	0,079	0,073	-0,118	-0,055	-0,004	0,050	0,029	-0,005	0,005	0,066	-0,001	-0,064
IG	-0,205	0,037	0,468	0,114	0,077	0,496	0,575	-0,340	0,304	-0,038	0,574	0,320
EXC	0,045	-0,018	-0,013	-0,034	-0,014	-0,022	-0,006	0,281	-0,051	-0,045	-0,059	-0,049
AC	0,541	0,250	0,093	0,646	0,719	0,141	0,159	-0,014	0,081	0,106	-0,030	-0,100
Dim.	Items											
	30	31	32	36	40	41	42	43	44	45	46	47
INT	0,467	0,616	0,358	0,487	0,685	-0,037	0,036	0,100	0,019	-0,012	-0,030	0,036
PAP	0,114	-0,051	-0,045	-0,108	0,039	0,895	0,919	0,179	0,376	-0,018	0,032	-0,030
IG	-0,134	-0,009	0,100	0,271	-0,009	0,020	0,005	0,098	-0,021	0,002	0,046	-0,024
EXC	0,087	-0,024	-0,091	0,019	-0,017	-0,023	0,015	0,120	0,056	0,753	0,741	0,624
AC	0,084	0,004	0,095	-0,052	0,053	-0,004	-0,015	0,002	0,130	0,009	-0,013	-0,007

Source: Own elaboration

Table 3
Characteristics of the Factors and Average Extracted Variance

Factors	Eigenvalue	Rotated Solution			Average Extracted Variance
		Sums of squared loadings	Variance Ratio	Acum. %	
1 – PAP	4,195	1,897	0,086	8,60	0,509
2 – IG	2,602	1,784	0,081	16,7	0,597
3 – INT	1,907	1,742	0,079	24,6	0,392
4 – EXC	1,415	1,696	0,077	32,4	0,678
5 - AC	1,178	1,560	0,071	39,4	0,471

Source: Own elaboration

The obtained indices, while satisfactory, do not fully explain the theoretical construct. It is important to acknowledge the limitations of the instrument and its sample, such as the gender imbalance and the variation in fields of knowledge among the respondents. Additionally, external factors beyond the researcher's control may bias the results [25].

Regarding the dimensions of Gender Ideology, Attitude, Interest, Perception, Self-Perception, and Expectations about Science, the predictive variables included in the model can explain 49.78%, 47.12%, 39.22%, 50.87%, and 67.77% of the total dimension, respectively, resulting in significant precision. Considering that the questionnaire is opinion-based, the minimum recommended value is 40%.

Other fit measures that have been considered include the Root Mean Square Error of Approximation (RMSEA), which had a value of 0.072; the Goodness of Fit Index (GFI), the Comparative Fit Index (CFI), the Incremental Fit Index (IFI), and the Tucker-Lewis Index (TLI), all of which were above 0.9, indicating a good fit of the model.

The normality test was conducted on five variables representing the items of each dimension: IG, AC, INT, PAP, and EXC. These variables are constructed by aggregating the elements. This test is performed to verify the compliance with the condition of a normal distribution of the data, with most of its values close to the mean – Null Hypothesis, H0. When contradicted, the alternative hypothesis (H1) is assumed.

The K-S test (Kolmogorov-Smirnov) was used, as the sample size is greater than 50. The p-value result for the five dimensions is below 0.05, indicating that there are significant differences for the sample. The SPSS-derived test uses the Lilliefors significance correction method to bypass sample limitations. Table 4 presents the descriptive values, including the maximum and minimum values of the aggregated variables, as well as the mean, standard deviation, variance, skewness, and kurtosis, which, for the studied sample, suggest a non-normalized distribution of the data.

The results show, through the observed statistical mean in Table 4, that the average response values for the dimension of Expectations about Science are the highest, indicating strong agreement that science is useful in daily and scientific life. On the other hand, the average response values for the other four dimensions indicate that the sample rejects the analyzed stereotypes related to Gender Ideology (IG), Attitude (AC), Interest (INT), and Self-Perception (PAP). However, in the PAP dimension, the standard deviation indicates that the sample exhibits greater variability in responses, with individuals potentially being completely in disagreement or agreement with the items. This suggests that caution should be taken regarding the biases these responses may identify. The skewness measures indicate that the IG and EXC dimensions present negative skewness, where the majority of the data is located on the right side of the axis. The kurtosis measure indicates that all dimensions, except EXC—which shows a significant concentration in the central region of the distribution—have data that are more spread out along their frequency histogram.

Table 4

Descriptivde Statistics

Dimensions	Min/max	Average	Standars Deviation	Variance	Skewness	Kurtosis
IG	1/3	1,663	0,519	0,27	-0,19	-0,916
AC	1/3	1,482	0,56	0,31	0,61	-0,671
INT	1/4	2,101	0,634	0,40	0,04	-0,224
PAP	1/4	2,297	0,806	0,65	0,15	-0,466
EXC	1/4	3,69	0,499	0,25	-1,32	1,154

Source: Own elaboration

Through the significance levels of the K-S test, which showed a value below 0.05 for all variables, the results also demonstrate that the distribution of the test is non-normal, leading to the rejection of the null hypothesis.

The correlations between the factors were evaluated, and as seen in Table 5, there is a strong correlation between the Interest (INT) dimension and both Gender Ideology (IG) and Attitude (AC); a moderate correlation with the Expectations (EXC) dimension; and a low correlation with Self-Perception (PAP). The PAP dimension shows a moderate correlation with IG, AC, and

EXC. The IG dimension correlates well with AC and EXC. In summary, the dimensions INT and IG; INT and AC; IG and AC; and IG and EXC are well related to each other.

Table 5
Correlations between Factors (covariances)

Dimensions	INT	PAP	IG	AC	EXC
INT	1	-0,077	0,792	0,447	-0,241
PAP	-0,077	1	-0,198	0,221	0,180
IG	0,792	-0,198	1	0,515	-0,566
AC	0,447	0,221	0,515	1	-0,192
EXC	-0,241	0,180	-0,566	-0,192	1

Source: Own elaboration

To analyze the reliability of the model, once the ordinal items that are part of a 4-point Likert scale are assessed, and considering that the model does not present a normal distribution, a Weighted Least Squares (DWLS) parameter estimator is used. For calculating the error using JASP, the robust method is chosen. All options are selected for standardization. Lavaan is chosen as the Mimic package to emulate results that would be presented using more common software.

Composite Reliability was analyzed to determine whether the constructs were interrelated. The average extracted variance was taken and divided by the sum of the squares of all standardized coefficients and the sum of the mean errors. Its interpretation is similar to that of Cronbach's Alpha, where values above 0.7 are considered reliable. Index values ranged from 0.74 to 0.86, indicating good reliability.

5. Discussion y Conclusions

The validation study of the QSTEMHE instrument has shown that, after its translation and adaptation for application in Brazil, it maintained coherence with the theoretical construct; that is, all items are correlated, while more strongly related groupings are also identified. Thus, the statistical values confirmed the instrument's ability to predict each variable with greater accuracy regarding each content designed by [2,3].

The model proved satisfactory through the values of total variance explained, with the five well-established dimensions perfectly capable of explaining what they propose. Other statistical measures indicated a good fit of the model.

The sample collected, after undergoing descriptive analysis, was representative and showed a balanced distribution within the Brazilian context. Additionally, the profile of the participants matched many aspects of the profile of the Spanish sample; for example, the majority of individuals in the respondents' immediate surroundings who had pursued STEM were men. The frequency of males was 59.31%, compared to 57.01% in Spain.

The instrument demonstrated high reliability, and its statistical evaluation validates the development of the analysis phase of university students' opinions on higher education in science, technology, engineering, and mathematics. In this way, shedding light on the opinions of these Brazilian students is an attempt to understand the dynamics that sustain the gender gap in STEM fields in Brazil, as [2,3] did in Spain. With an accurate diagnosis, effective solutions can be found.

It is important to emphasize that the subjectivity inherent in the nature of emotions, human behavior, and historical constructs imposes certain limitations on the analyses. Considering the need for individuals to justify their opinions, feelings, and attitudes, the collected data may not reflect people's actual thoughts, but rather what they say they think [25]. These aspects can lead to variations in the recorded opinions. However, the importance of conducting research through surveys cannot be understated, as it provides direction toward a better understanding of the issue despite its biases.

Ultimately, this study broadens the possibilities for advancing understanding from a more comprehensive perspective. Comparing the results from Brazil and Spain is a further step in this research, allowing us to appreciate how different cultural contexts influence the opinions of a group that has access to higher education. Once inferential analyses are conducted, the results may indicate more effective solutions for addressing gender inequality in STEM fields.

References

[1] S. Verdugo-Castro, A. García-Holgado, M. C. Sánchez-Gómez (2024). Cuestionario de opinión con universitarios/as sobre los estudios superiores en ciencia, tecnología, ingeniería y matemáticas (QSTEMHE) (Informe Técnico GRIAL-TR-2024-001). Recuperado de https://repositorio.grial.eu/handle/grial/3034 Salamanca, España: Grupo GRIAL. doi: 10.5281/zenodo.10671772.

[2] S. Verdugo-Castro, M. C. Sánchez-Gómez, and A. García-Holgado, "Opinions and Perceptions about STEM Studies in Higher Education: An Exploratory Case Study in Spain," Education in the Knowledge Society, vol. 23, 2022, doi: 10.14201/eks.27529.

[3] S. Verdugo-Castro, M. C. Sánchez-Gómez, and A. García-Holgado, "University students' views regarding gender in STEM studies: design and validation of an instrument," Educ. Inf. Technol., vol. 23, 2022, doi: 10.1007/s10639-022-11110-8.

[4] S. Verdugo-Castro, A. García-Holgado, M. C. Sánchez-Gómez, M. A. Milfont Shzu (2024). Questionário de opinião com universitários/as sobre os estudos superiores em ciência, tecnologia, engenharia e matemática (QSTEMHE) (Relatório Técnico GRIAL-TR-2024-003). Recuperado de https://repositorio.grial.eu/handle/grial/3035 Salamanca, España: Grupo GRIAL. doi: 10.5281/zenodo.10671853.

[5] Likert, R. (1932). A technique for the measurement of attitude. *Archives of Psychology*, *140*, 5-55

[6] Carroll JM, Yeager DS, Buontempo J, Hecht C, Cimpian A, Mhatre P, et al. Mindset × Context: Schools, Classrooms, and the Unequal Translation of Expectations into Math Achievement. Monographs Society Res Child. 2023 Sep;88(2):7–109.

[7] Fioreze C. Policy initiatives on the right to higher education in Brazil (Tracing Good and Emerging Practices on the Right to Higher Education) [Internet]. NESCO IESALC; 2023 [cited 2024 Jan 18]. Available from: https://unesdoc.unesco.org/

[8] IBGE. Síntese de Indicadores Sociais 2023. Uma análise das condições de vida da população brasileira 2023.

[9] OECD. Education at a Glance 2023: OECD Indicators [Internet]. OECD; 2023 [cited 2024 Jan 9]. (Education at a Glance). Available from: https://www.oecd-ilibrary.org

[10] World Economic Forum 2023. The Global Gender Gap Report 2023 [Internet]. 2023. Available from: https://www.weforum.org/publications/global-gender-gap-report-2023
[11] O'Connor P. Is gendered power irrelevant in higher educational institutions? Understanding the persistence of gender inequality. Interdisciplinary Science Reviews. 2023 Oct 2;48(4):669–86.
[12] INEP 2022. Censo da Educação Superior Brasil [Internet]. 2023. Available from: https://download.inep.gov.br/educacao_superior/censo_superior
[13] Verdugo-Castro S. La brecha de género en los estudios universitarios del sector STEM en el espacio español de educación [Internet]. Universidad de Salamanca; 2022. Available from: http://hdl.handle.net/10366/150723
[14] BRASIL. Resolução nº 510, de 07 de abril de 2016, do Conselho Nacional de Saúde. Dispõe sobre as normas aplicáveis a pesquisas em Ciências Humanas e Sociais. Brasília: Conselho Nacional de Saúde, 2016.
[15] Hernández Sampieri, R., Fernández Collado, C., & Baptista Lucio, P. Metodologia de la Investigación. 2014. (6th ed.). McGraw-Hill.
[16] Molinero Hernando F. El espacio rural de España: evolución, delimitación y clasificación. Cuadernos Geográficos. 2019 Dec 18;58(3):19–56.
[17] IBGE 2023. Proposta metodológica para classificação dos espaços do rural, do urbano e da Natureza no Brasil. 2023. Available from: http://journals.openedition.org/confins/53955
[18] IBGE. Pesquisa Nacional por Amostra de Domicílios Contínua 2019. Desigualdades Sociais por Cor ou Raça no Brasil. 2020 ISBN 978-85-240-4513-4
[19] CNPq. Conselho Nacional de Desenvolvimento Científico e Tecnológico. Diretório de Grupos de Pesquisa (DGP). Microdados. Censo 2023. Available from: https://lattes.cnpq.br/web/dgp/painel-dgp/. Accessed in: 17/01/2024
[20] INEP. Censo da Educação Superior Brasil [Internet]. 2023. 79 p. Available from: https://download.inep.gov.br/educacao_superior/censo_superior
[21] INEP. Censo da Educaçao Superior Brasil 2017 [recurso eletrônico]. – brasília : instituto nacional de estudos e Pesquisas educacionais anísio teixeira, 2019. 2019. 112 p.
[22] Instituto Semesp. Mapa do Ensino Superior no Brasil 2021. 11th ed. 2021. 302 p.
[23] Osborne JW. What is Rotating in Exploratory Factor Analysis? Practical Assessment, Research & Evaluation. 2015 Jan;20(2). Available from: http://pareonline.net
[24] Abad, F. J., Olea Díaz, J., Ponsoda Gil, V., & García García, C. (2011). Análisis factorial confirmatorio. In Medición en ciencias sociales y de la salud (pp. 341–384). Síntesis. https://dialnet.unirioja.es/servlet
[25] Eynde AMVD, Laspra B, García ID. El estudio de la cultura científica. El cuestionario PICA sobre percepción, interés, conocimiento y acciones relacionadas con la ciencia. 2016 [cited 2023 Dec 21]; Available from: http://rgdoi.net/10.13140/RG.2.2.33702.32321