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Underlying dimensions in attitude towards technology in a sample of Spanish, German and Indian women

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Abstract

Background: The underrepresentation of women in the field of technology, their progressive disappearance from scientific and technological careers, as well as women's disaffection towards technology continues to prevail despite efforts that are being made. This article is an analysis of the early results of a study on women's attitudes towards technology. **Method:** We prepared a questionnaire about attitudes towards technology building on previous research. By means of a convenience sampling, followed by a snowball sampling strategy, we presented a questionnaire to 497 women (Spanish, German and Indian). **Results:** By means of a Principal Components Analysis, we have identified two dimensions: 1) Attitude related to the experience with technology entrenched in gender stereotypes; 2) Attitude to the ability to teach and learn ICT. **Conclusions:** Similarities have been shown among the groups of women of different nationalities, in terms of the interpretation of these dimensions, but not for the set of items summarized in each one of them. In addition, a third dimension was obtained in the group of women from India: attitude related to the role of gender in relation to technology.

Keywords

Gender, attitudes, technology, information and communication technologies.

Dimensiones subyacentes en la actitud hacia la tecnología en una muestra de mujeres españolas, alemanas e indias

Resumen

Antecedentes: La infrarrepresentación de las mujeres en el ámbito tecnológico, su desaparición progresiva de las carreras científicas y tecnológicas, así como la desafección hacia la tecnología por parte de las mujeres sigue prevaleciendo a pesar de los esfuerzos que se vienen realizando. En este trabajo analizamos los primeros resultados de un estudio sobre las actitudes hacia la tecnología por parte de las mujeres. **Método:** Construimos un

cuestionario de actitudes hacia la tecnología partiendo de investigaciones previas. Mediante un muestreo por conveniencia, siguiendo posteriormente con una estrategia muestral de bola de nieve, lo administramos a 497 mujeres (españolas, alemanas e indias). **Resultados:** Mediante un análisis en componentes principales hemos identificado dos dimensiones: 1) actitud relacionada con la experiencia con la tecnología imbricada con los estereotipos de género; 2) actitud con respecto a la capacidad en enseñar y aprende las TIC. **Conclusiones:** Se han mostrado similitudes entre los grupos de mujeres de distintas nacionalidades en cuanto a la interpretación de las dimensiones, pero no para el conjunto de ítems que se resume en cada una de ellas. Además, en el grupo de mujeres de la India, se obtuvo una tercera dimensión: actitud relacionada con el rol de género frente a la tecnología.

Palabras clave

Género, actitudes, tecnología, tecnologías de la información y la comunicación.

INTRODUCTION

Despite efforts to reduce the digital gender gap through policies and strategies toencourage girls and women to be leaders in technology, apparently, they are not delivering the desired results (UNESCO, 2017; European Commission, 2019). Li, Kirkup and Hodgson (2001, p. 415), identified that "most studies show that women are less enthusiastic and less trusting of technology, spend less time on a computer, and are unlikely to choose a technology-related career". This results in situations of under- representation of women in technological contexts, such the progressive disappearance of women from scientific and technological careers (Castaño & Webster, 2011; Instituto de la mujer y para la igualdad de oportunidades, 2017), the low presence of women in technological professions (Martínez-Cantos & Castaño, 2017; OECD, 2017), and disaffection towards technology – which is manifested in more unfavourable attitudes towards its use (Cai, Fan & Du, 2017).

During childhood, girls show technical abilities and ICT skills equal to or better than those of boys (Aesaert & van Braak, 2015). However, over the course of their formative and professional lives, most studies highlight the dwindling presence of women in the fields of information and communication technologies (ICT), and their progressive abandonment of these fields (Gil-Juárez, Feliu, Vall-llovera & Biglia, 2013).

In this context, there have been numerous studies carried out over the past 20 years in which women's use of and incorporation in ICT has been analysed. It has been found that "in the last few years, despite the use of ICT appearing to have been equal between men and women, this has not been accompanied by the effective incorporation of women into the strategic sectors of training, research and enterprise" (Gil-Juarez, Vitores & Feliu, 2015, p. 82). In addition,empirical studies on gender differences in attitudes towards technology highlight aspects in their results which are not exactly encouraging, such as: women tend to have a less positive attitude in the face of and towards technology in general; they show less confidence in their abilities to learn and use it naturally; and the cultural and social context influences the gender differences observed with respect to attitudes towards ICT (Cai et al., 2017).

Since the advent of ICT, the study of attitudes towards technology has constituted, and remains, an important field of interest. That is why, in this article, we look at the initial results of a study on women's attitudes towards technology, specifically, their "beliefs related to how they value the use of technology and its social function" (Cai et al., 2017,from Fishbein & Bertram, 1962). In this case, we are interested to know which dimensions underlie women's disaffection with technology, and which bring them closer to or move themaway from it based on their technology-related beliefs.

In addition, it has been found that there is significant variability between Western and non-Western countries. The non-Western countries show a higher percentage of women present in the field of technology, especially in India and Malaysia, where it does not seem to be related to male stereotypes. The research shows "a significant increase in the numberof women pursuing a bachelor's degree in Computer Science has been recently described in India, where the field is even seen as being 'woman-friendly'" (Vitores & Gil-Juárez,2017). So the cultural environment is a variable to take into account to understand gender-ICT relationships.

Given the above, our intention is to identify the underlying dimensions of attitudes towardstechnology, through a questionnaire about attitudes put together ad hoc and administered to Spanish, German and Indian women.

METHOD

Participants

In this study, 497 women from three different nationalities participated voluntarily: 366 from Spain, 61 from Germany, and 70 from India. The sample was gathered through a convenience sampling, and then followed by a sample snowball strategy (Lohr, 2000). The first contact was established through students of the virtual Practicum II on Young ICT Research and Gender, from the Psychology Degree programme at the Universitat Oberta de Catalunya, who lived in Spain, Germany and India. By proximity, they contacted key informant women whom they approached directly, explaining the goals of the research and inviting them to participate. In turn, they were asked to recruit other women through their social networks, encouraging them to participate. In this way, we generated a wide profile of women – in terms of age, level of studies, and profession – from thethree countries mentioned. The characteristics of the sample can be seen in **Table 1.**

In terms of their relationship with technology, 65.85% of Spanish women reported havingaccess to computer science only at a user level, while this percentage was higher for women of German and Indian nationality – 86.9% and 82.9% respectively. As for their perception of the time they had spent on technological learning compared to the men around them, 34.7% and 48.6% – Spanish and Indian, respectively – indicated that they had spent less time than men did, while, in the case of German women, this reached 63.9%. In addition, only 25.7% and 33.3% of Indian and Spanish women, respectively, were not as encouraged to do technical studies as their male peers, while for German women this percentage increased to 60.7% of women.

TABLE 1

Instruments

The tool we used in this study was a questionnaire aimed at exploring women's attitudes towards technology, the content of which we designed based on the results and conclusions from previous research (Sánchez, Ortega y Vall-llovera, 2012; Gil-Juarez, Vitores & Feliu, 2015; Gil-Juárez, Feliu, Vall-llovera, Calsamiglia y Conesa, 2015). When drafting the questionnaire, we took into account the essential aspects which must be considered to ensure its meticulous construction (Muñiz & Fonseca-Pedrero, 2019).

The questionnaire has three sections. The first includes census information: age, countryof birth and residence, educational background, and profession. The second section consists of three statements about the woman's use of technology, the time they spend comparedto the men around them, and whether they were encouraged to do less technological studies than their male peers. The answers to these questions is dichotomous.

The third section consists of 20 items written as affirmations describing technology- related situations. Initially, this section consisted of 30 items which were submitted for evaluation by three expert judges, who, after evaluation, then selected the 20 items to be included in the definitive questionnaire. Of these, the top ten were positively formulated and the other ten were inversely recoded (see the contents of the items in **Table 2**). The format of responses used a Likert-type scale of 1 to 5 (1 = strongly disagree, to 5 = strongly agree) (Likert, 1932).

Procedure

Using Google's electronic forms tool (Google Forms), we ask closed women for their participation by email. This email outlined the objectives of the study and the conditions of participation, and a link to the questionnaire was attached. Once these women had answered the questionnaire, they forwarded it to other women with whom they had a close relationship, through WhatsApp groups or by email, for example.

The questionnaire was made available in three languages (Spanish, German and English), and its translation from Spanish was reviewed by experts in each of the other two languages. In addition, prior to the census questions, we included a brief description of the study, how it was to be answered, and how long it would take to complete; confidentiality and anonymity of the women were guaranteed.

Thus, we obtained a total of 647 completed questionnaires (440, 88 and 119 in Spanish, German and English, respectively).

Data Analysis

We conducted a first analysis of the responses given to the 647 questionnaires in order torefine the data. In this phase, we eliminated 74 questionnaires from the initial 440 in Spanish under the criterion of preserving those that did not have missing values; 22 questionnaires in German were also eliminated for the same reason. Regarding the questionnaires in English, we removed 49 of them on the basis of two criteria: 1) we chose the English-speaking country that had the most responses, which was India, and 2) once the country was selected, we eliminated those questionnaires which had been submitted withmissing values.

The data we analysed corresponded to 366 Spanish women, 61 German women, and 70 English-speaking Indian women. First, we carried out a descriptive analysis of the responses to the first and second sections of

Table 1. *Description – in percentages – of the Spanish, German and Indian samples, by age, level of studies, profession, and perception of their relationship with technology.*

	Spain n = 366	Germany n = 61	India n = 70
Age			
< 20	1.4	3.3	51.4
21- 30	26.8	34.4	14.3
31 - 40	34.2	31.1	32.9
41-50	22.7	21.3	1.4
51-60	11.5	3.3	0
> 60	3.6	6.6	0
Level of studies completed			
Primary school	1.1	0	2.9
Secondary school	2.2	41.0	44.3
Technical school/Professional license	10.4	18.0	4.3
High school	15.6	0	0
University degree	70.5	36.1	47.1
Other	3.0	4.9	1.4
Profession			
High school student	3.0	3.3	42.9
College student	11.2	16.4	8.6
Part-time employee	12.3	14.8	5.7
Full-time employee	48.9	57.4	17.1
Self-employed	8.5	3.3	5.7
Unemployed	7.1	0	0
Full-time housewife/homemaker	2.7	0	18.6
Other	8.7	4.9	1.4
I have a very basic understanding of computers			
Yes	65.8	86.9	82.9
No	34.2	13.1	17.1
I spend less time learning about computers than the men around me			
Yes	34.7	63.9	48.6
No	65.3	36.1	51.4
I was not encouraged as much as my friends to study technology			
Yes	33.3	60.7	25.7
No	66.7	39.3	74.3

the questionnaire (Table 1). Later, an exploratory factor analysis using a principal components method was calculated for the 20 items of the third section of the questionnaire for each country. This was done in order to describe the structure of the relationships between them, for each of the three nationalities. Prior to the principal components analysis, we recoded the inverse items so that those with high scores signified a positive attitude towards technology. These analyses were performed with the SPSS Statistics v. 23 program.

RESULTS

Exploratory factor analysis

According to the results of exploratory factor analysis and adjustment criteria used to select the relevant components (Viladrich et al., 1999), from each group we eliminated items with little or no relation to others (correlations with a component of less than 0.3). Once these were eliminated, and after a second analysis (PCA) and varimax rotation, the model that best matched the orig-

inal data was that of two components for the groups of Spanish and German women, and three for the Indian women's group. Table 2 provides asummary of the results obtained, as well as the internal consistency index – alpha Cronbach – for the total (α_{total}) of the items preserved in each group.

TABLE 2

Group of Spanish women

We eliminated items 6, 10, 11, 12 and 14. From the rotated factorial solution, for the 15 items we kept, we identified two conceptual groupings. On one hand, in component one (C1) items 1, 5, 7, 8, 9, 13, and 15 to 20 are summarized, the contents of which are basically related to the women's experience with technology and in which there are underlying gender stereotypes. On the other hand, the second component (C2) groups those items (2, 3 and 4) related to people's ability to deal with technology, and to teach and learn it, i.e., the ability of men and women to cope with information and communication technologies (ICT) (**Table 2**).

Group of German women

We kept 16 items, after deleting items 6, 8, 10 and 11, which coincided with the group of Spanish women regarding items 6, 10 and 11. In interpreting the two-component rotated factorial solution, we noted that items 12 and 14, which directly relate to conceptions of gender stereotypes, are summarized in the first component (C1). These are items that, together with items 1, 5, 7, 9, 13, and 15 to 20, continue to refer to the experience with technology, and in which there are underlying gender stereotypes. In the case of the second component (C2), items 2, 3 and 4, related to the capabilities of men and women regarding ICT, are summarized again (**Table 2**).

Group of Indian Women

The model that best matched the original data was the three-component model. In this case, previously, we deleted a single item (10) and kept the remaining 19 for analysis. The three-component solution grouped items 9, 11, and 12 (C3) apart from the rest. Analysing their content, they are items that deal with the role of gender in relation to the concept of technology (it is cold and lonely; fun and games), and who makes use of it. The second component (C2), in the cases of Spain and Germany, summarizes items 2 to 4 – the capabilities of men and women regarding ICT. Finally, for the first component (C1), in the rotated solution (Table 2), items 1 and 6 have correlations of less than 0.3 with the other items summarized therein. It should be noted that in the case of item 6, it was removed from the Spain and Germany groups for the same reason once the first PCA was carried out. However, this is not the case with item 1, which should not be taken into account for this group, like item 6, for this component (C1). Thus, we can consider that the first component would summarize items 5, 7, 8, and 13 to 20, which make statements concerning experience with technology and underlying gender stereotypes.

Comparison of the three groups

At this point in the analysis, we considered reflecting on what the three groups of women share, and what their differences are. The comparative summary can be found in **Table 3**.

TABLE 3

Items 5, 7, 13, and 15 to 20 match in the three groups in the first component (C1). These share the same characteristics related to: enjoyment and/or difficulty, and challenges or problem-solving in the field of technology. We therefore interpret that this set of statements would be part of a dimension in which the pleasure of facing a technological challenge is valued. As for items 2, 3 and 4, which, in all three groups, have moderately high and even high correlations (> 0.8) in the second component (C2), as we have discussed above, assess the capabilities of men and women regarding ICT.

In contrast, items 1, 8, 9, 11, 12 and 14, which coincide with content which appeals to gender stereotypes in relation to ICT, in each group different components are summarized. We note that for items 8 and 9, in the group of Spanish women, they correlate with the first component (C1), and these coincide with the Indian and the German group, respectively; while item 14 correlates with the same component (C1) in the German and Indian groups; and items 11 and 12 behave differently in each of the groups. The low value for item 1 in the three-component solution for the Indian group is highlighted, although it does coincide in the correlation in the same component for the groups from Spain and Germany. Finally, item 10, which is the only statement regarding the possibilities offered by ICT to reconcile private life and work, was an item that we removed for all groups given its null relationship with the other statements.

CONCLUSIONS

The results have shown us similarities among groups of women of different nationalities in the dimensions underlying women's attitudes towards ICT. Thus, in a first dimension (C1) we can summarize that the attitude re-

Table 2. *The rotated factorial saturations (Varimax) obtained from the PCA, percentagesof total variance explained (% σ2t) and total Cronbach alpha coefficients (α_{total}), for thegroups of Spanish, German and Indian women (the items which were removed from someof the groups are in italics).*

	Germany		India		Spain		
	(n = 61)		(n = 70)		(n = 366)		
	C1	C2	C1	C2	C1	C2	C3
% σ^2_t	49.7		42.5		45.9		
α_{total}	.860		.824		.824		
Items							
1. Computers are machines which are simple to use	.434		.570		.130*		
2. Men and women are equally capable of using technology		.865		.544		.663	
3. Men and women are equally capable of teaching computer technology		.856		.793		.696	
4. Men and women are equally capable of learning computer technology		.915		.731		.572	
5. I really enjoy working with computers	.783		.484		.648		
6. If I was more advanced with computer technology, my friends would admire me more					.105*		
7. I enjoy solving computer problems	.655		.657		.674		
8. I would like to choose a computer science degree because it would allow me to work from home and have a more balanced professional and private life	.481				.541		
9. It is not true that computer technology makes people socially isolated	.482		.447				.480
10. It is easier to have a balanced work and private life when working in technology							
11. Girls who like technology are less feminine than others							.344
12. Playing videogames is a boy's thing			.340				.603
13. When I have problems with a computer, it's because I'm really bad with them	.611		.692		.571		
14. I think that it is more acceptable for a woman to know less about computers than for a man			.597		.340		
15. I'm not really interested in studying computer science	.777		.314		.745		
16. I think that technology-related jobs are boring, and I'm not interested in them	.764		.612		.727		
17. I don't enjoy playing most videogames	.487		.546		.529		
18. I think that computer classes are boring	.714		.638		.700		
19. I'm more likely than a boy to stop working on a task when presented with technological challenges	.539		.803		.482		
20. I use technology, but I don't enjoy it	.728		.740		.565		

lated to experience with technology overlaps with gender stereotypes, and, in a second dimension (C2), so does the attitude regarding the ability to teach and learn ICT.

However, these matches are dependent on interpretation of the dimensions, but not dependent on the set of items that are summarized in each of them. We refer in particularto the first dimension, in which the items that form part of it vary according to the nationality of the women. In addition, in the case of the Indian women's group, we achieved a third dimension (C3): the attitude related to the role of gender in technology. These differences between India, Spain and Germany, as well as those we have observed for the first dimension, may be attributable to the existence of cultural differences in terms of viewpoint and perception of ICT (Li & Kirkup , 2007; Vitores & Gil-Juárez, 2015).

Table 3. *Convergences and divergences in the results of the solutions from the PCA between the Spanish, German and Indian women's groups (in italics: coincidences in items to be deleted; in bold: coincidences in items grouped in the same components in thethree groups; with an asterisk: the deviations).*

	Germany		India		Spain		
	C1	C2	C1	C2	C1	C2	C3
% σ^2_t	49.7		42.5		45.9		
α_{total}	.860		.824		.824		
Items							
* 1. Computers are machines that are simple to use	.434		.570		.130*		
2. Men and women are equally capable of using technology		**.865**		**.544**		**.663**	
3. Men and women are equally capable of teaching computer technology		**.856**		**.793**		**.696**	
4. Men and women are equally capable of learning computer technology		**.915**		**.731**		**.572**	
5. I really enjoy working with computers	**.783**		**.484**		**.648**		
6. If I was more advanced with computer technology, my friends would admire me more					*.105**		
7. I enjoy solving computer problems	**.655**		**.657**		**.674**		
8. I would like to choose a computer science degree because it would allow me to work from homeand have a more balanced professional and private life	.481				.541		
9. It is not true that computer technology makes people socially isolated	.482		.447				.480
10. It is easier to have a balanced work and private life when working in technology							
* 11. Girls who like technology are less feminine than others							.344
* 12. Playing videogames is a boy's thing			.340				.603
13. When I have problems with a computer, it's because I'm really bad with them	**.611**		**.692**		**.571**		
* 14. I think that it is more acceptable for a woman to know less about computers than for a man			.597		.340		
15. I'm not really interested in studying computer science	**.777**		**.314**		**.745**		
16. I think that technology-related jobs are boring, and I'm not interested in them	**.764**		**.612**		**.727**		
17. I don't enjoy playing most videogames	**.487**		**.546**		**.529**		
18. I think that computer classes are boring	**.714**		**.638**		**.700**		
19. I'm more likely than a boy to stop working on a task when presented with technological challenges	**.539**		**.803**		**.482**		
20. I use technology, but I don't enjoy it	**.728**		**.740**		**.565**		

The visual analysis comparing the results of the rotated solutions for the three groups has shown us that the same subset of items is maintained, and summarized, in the first dimension (C1), specifically those whose content relates to the affinity for or interest in ICT and the challenges it can offer, an attitude that can be interpreted as "being a girl [or woman] determines clear appetites and tastes in terms of what can and cannot be done, and that appreciation is treated as something obvious" (Gil-Juárez, Vitores, & Feliu, 2015, p. 88). Finally, we should also mention those items in the different groups that have been summarized in different dimensions, and that coincide with content that appeals to gender stereotypes in relation to ICT that traditionally attribute pleasure (and their "mastery") to men (Vergès Bosch, 2012).

Limitations

At the outset, we said that we were interested in knowing the dimensions underlying women's attitudes of proximity to or estrangement from ICT. The first results obtained from a questionnaire answered by three groups of women of three different nationalities have revealed to us, as we have already seen, two dimensions. However, the validity of the inferences and interpretations that can be made from the questionnaire, as well as their reliability, must be tested in future surveys on the basis of the results obtained.

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