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Secondary students' perceptions in Melilla on the use of digital technologies in Mathematics

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ABSTRACT

The integration of Information and Communication Technologies (ICT) has transformed mathematics teaching, promoting interactive and adaptive methods, especially in multicultural contexts such as Melilla (Spain). This quantitative cross-sectional study analyzed the perceptions of 2,018 secondary school students on the contribution of ICT to academic performance in mathematics. Conditional probability analysis showed that frequent communication with teachers and the use of ICT in mathematics assignments are associated with positive perceptions. Ordinal logistic regression identified key factors such as gender, ICT use at home, and digital communication. A discriminant analysis defined a predictive model based on domestic ICT use, perception of mathematics work, communication with teachers, and educational level. The importance of policies that guarantee equitable access to ICT to reduce gender gaps and promote inclusive and effective education is highlighted.

Keywords: secondary education, mathematics, perception, information and communication technologies.

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1. Introduction

The integration of Information and Communication Technologies (ICT) into mathematics teaching has revolutionized pedagogical models, offering collaborative and visual environments that facilitate the understanding of complex concepts. This integration facilitates interactive and adaptive learning (Hu et al., 2020). At the same time, ICT provides multilingual resources and collaborative platforms that enrich the educational process and reduce gaps (Skvarc et al., 2021). Similarly, ICT allows for flexible learning with resources adapted to each student's pace. This flexibility facilitates reviewing material and improves information retention (Li and Wong, 2018). Accessing diverse sources promotes better understanding and application of mathematical concepts (Rodríguez-Jiménez et al., 2023; Tashtoush et al., 2023).

In mathematics, ICT has specific potential to improve understanding and application in real-life situations, thereby enhancing academic performance (Muslim et al., 2023). Applications such as Wolfram Alpha, for algebra (Botuzova, 2020), and GeoGebra, for geometry and functions (Hasek, 2019), significantly improve these aspects. Likewise, assigning tasks that require ICT encourages its regular use and improves perceptions of its academic usefulness in mathematics (Tashtoush et al., 2023). The perception of working better with digital technologies is related to motivation and academic engagement: when students perceive that ICT improves their work in mathematics, their intrinsic motivation and academic performance increase (García-Vandewalle et al., 2023; Lee and Yeo, 2022).

Various studies support the selection of certain key factors that influence the perception and effective use of ICT in mathematics. Gender can influence interaction and performance due to differences in access, attitudes, and confidence. For example, Nino-Cortés et al. (2023) found that female students tend to show less confidence in the use of ICT, which affects their participation and achievement in mathematics. In addition, sociocultural contexts can reinforce gender stereotypes that influence attitudes towards ICT and mathematics (Siddiq and Scherer, 2019). Similarly, educational level affects familiarity with these technologies. Adelantado-Renau et al. (2019) indicate that students at higher levels have greater experience and skills in ICT, facilitating their integration into mathematics, while students at lower levels may require more support to use them effectively.

Previous academic performance also affects perceptions of the impact of ICT. Benítez-Díaz et al. (2019) indicate that students with high grades see ICT as an enabler of learning, while those with low academic performance may feel demotivated. Furthermore, family economic status determines technological access: families with greater resources often have access to high-quality devices and connections, while economic limitations restrict access, widening educational gaps (Dodel, 2022). Furthermore, owning a laptop influences academic progress, but not necessarily performance (Reisdorf et al., 2020). Skvarc et al. (2021) indicate that regular use of technological resources improves technical skills, confidence and academic engagement.

On the other hand, the exchange of educational information through ICT increases collaboration and mutual support in peer learning (Carvalho and Santos, 2020). Likewise, digital communication with teachers improves academic support and the perception of ICT as useful tools (Sipilä, 2014). This constant digital interaction promotes student engagement, quickly resolves doubts, allows for continuous feedback, and encourages active participation, improving academic performance (Bond, 2020; Joshi et al., 2023).

The autonomous city of Melilla is a particularly relevant context for analyzing the impact of ICT. According to the 2021 State School Council Report, this region has one of the highest rates of early school leaving in Spain (24.1%), significantly above the national average of 17.3% (Cuenca et al., 2021). In addition, its high student-to-classroom ratio (29.6 in secondary school) and the cultural diversity of Melilla, with more than 50% of students from different communities, highlight the importance of ICT in complementing teaching and reducing educational gaps.

This relevance is reinforced when considering Melilla's socio-economic status, which faces significant challenges. According to the 12th Report on the State of Poverty in Spain, produced by the European Anti-Poverty Network, 37.6% of the population is at risk of poverty or social exclusion, a figure that remains one of the highest in the country (European Anti-Poverty Network, 2022). This vulnerability limits access to and use of educational technology resources. For this reason, the Ministry of Education and Vocational Training, through the Recovery, Transformation and Resilience Plan for Education, is allocating 3 million euros for digital classrooms and technological devices, according to Royal Decree 988/2021. Economic inequality can limit the use of these resources outside the school environment. In this context, ICTs provide equal learning opportunities. In addition, the high unemployment rate (24.7%) and youth unemployment, which accounts for 74% of the total (Ministry of Territorial Policy, 2022), underscore the need for initiatives that promote digital skills from an early age to improve future employability.

In this regard, with adequate digital competence among teachers (García-Vandewalle et al., 2023), ICT can significantly improve student motivation and academic performance (Li and Zhu, 2023) by facilitating the understanding and manipulation of complex concepts and adapting learning to individual needs (Adelantado-Renau et al., 2019).

However, there are risks of distraction and possible superficiality in learning that can arise from excessive (Gorjon and Oses, 2023) or inappropriate use of these digital technologies (García-Gil et al., 2022). Furthermore, differences in access to and familiarity with ICTs can amplify educational inequalities (Erdogdu and Erdogdu, 2015). Therefore, effective integration of digital technologies in mathematics teaching lies in balance and moderation, using technologies as a complement to conventional approaches (Sasota et al., 2021).

Therefore, analyzing how students perceive digital technologies and their impact on academic performance in mathematics provides valuable information for developing more inclusive and effective educational strategies (Verschaffel et al., 2019).

1.1. *Research objectives*

The overall objective of this study is to analyze factors that influence the perceived usefulness of ICT among secondary school students in Melilla for learning mathematics. The specific objectives are:

- SO1. Explore how sociodemographic variables (gender, economic status), academic variables (previous grades, educational level) and digital interaction variables (use of ICT at home, digital communication with teachers, digital information exchange) influence students' perceptions of the contribution of ICT to their mathematics grades.
- SO2. To evaluate the predictive potential of sociodemographic, academic and digital interaction variables regarding students' perceptions of the contribution of ICT to their mathematics grades.
- SO3. Identify the predictive variables that contribute to significant differences between the different degrees of perception regarding the contribution of ICT to the improvement of mathematics grades.

2. Method

A quantitative cross-sectional study with a non-experimental *ex-post-facto* design is carried out as part of a broader research project.

2.1. *Participants and data collection*

The population included students aged 11 to 18 enrolled in secondary school and sixth form in Melilla during 2018-2019, using non-probabilistic convenience sampling. A questionnaire was administered to all groups and levels, with authorization from the Educational Programs Unit and informed consent from parents or guardians. The study was approved by the Ethics Committee of the National Distance Education University (UNED), with reference number 31-SISH-EDU-2024. Data was collected in computer rooms under the supervision of a teacher and a researcher, who informed the students about the objectives and the anonymous and voluntary nature of the study. Only those who had given their consent accessed the digital questionnaire in Google Forms.

A total of 2,018 students participated (53.26% female), equivalent to 34.35% of the population (5,875 students, 53.40% female). The loss of participants was due to the voluntary nature of the study and the requirement for consent from parents or legal guardians. The sample is distributed as shown in Figure 1.

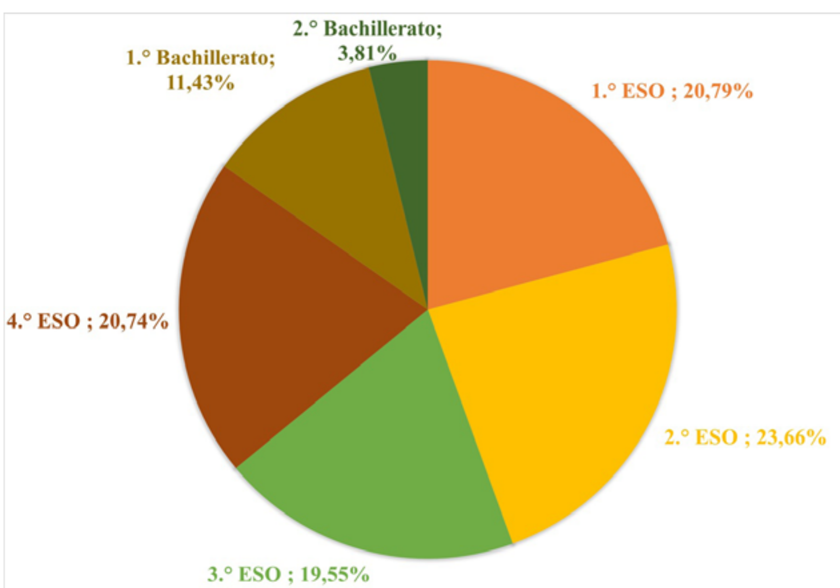

Figure 1. *Distribution of students by educational level. Own elaboration*

2.2. *Instrument*

The instrument used, consisting of 140 items, was developed to analyze aspects of students' relationship with ICT and mathematics. Its creation was based on relevant literature to identify dimensions and formulate the items (Baya'a et al., 2019; Tourón et al., 2018; Zahorec et al., 2019). A 4-point Likert scale was used to avoid excessive interpolations (Nadler et al., 2015). Ten experts evaluated clarity, relevance, and representativeness, resulting in adjustments to 13 items and the elimination of 5 redundant items, reducing the total to 135. The panel included three school principals, three mathematics department heads, an ICT coordinator, and three university lecturers, all with more than 20 years of experience.

The instrument's IVC (0.84) exceeded the recommended threshold (0.80), indicating that the items are adequate and representative (Davis, 1992). This value reflects a high degree of agreement among experts, supporting the validity of the instrument.

The instrument used explores how students perceive the impact of ICT on their learning, considering opinions, attitudes, and beliefs about its effectiveness as academic tools. Of the 140 original items, 11 were selected in line with the study's objectives, focusing on the perceived impact of ICT on mathematics, digital interactions, and socio-economic status. The selection is based on the relevance of these factors to the educational context of Melilla, characterized by its cultural uniqueness, social diversity and structural inequalities that condition access to and use of technologies in the educational environment.

Dimension A collects sociodemographic and academic data such as gender, educational level, mathematics grades, and family economic status. Dimension E analyses the use and perception of ICT in mathematics through three indicators: use at home, usefulness for improving mathematics, and frequency of ICT activities assigned by teachers. Dimension F addresses digital interactions between students, peers, and teachers (see Table 1).

Subsequently, the psychometric properties were evaluated using McDonald's Omega (reliability) and Exploratory Factor Analysis (EFA; validity) in dimensions E and F, which reflect an underlying construct. The initial analysis identified three factors with eigenvalues > 1, but after varimax rotation, they were grouped into two main components: Component 1 (contribution of ICT to learning: TMN, TTM, ATC) and Component 2 (digital collaboration: CIC, CPI, CCI). Dimensions A (socio-demographic data and academic performance) and G (broad perceptions of ICT) were excluded. McDonald's Omega showed adequate internal consistency: 0.773 for dimension E and 0.743 for F. The KMO measure indicated a marginal level of adequacy (0.620), and Bartlett's sphericity test confirmed suitability for CFA (X2= 2854.97, p = 0.000). With factor extraction by unweighted least squares, the highest communalities were: 0.999 (CIC), 0.812 (TMN), 0.718 (TTM), 0.396 (CPI), 0.231 (ATC) and 0.187 (CCI). The components explained 75.72% of the cumulative variance: 39.03% (factor 1), 19.43% (factor 2) and 17.25% (factor 3). After varimax rotation, the adjusted loadings were Component 1 (TMN: 0.934, TTM: 0.768, ATC: 0.225) and Component 2 (CIC: 0.847, CPI: 0.433, CCI: 0.432).

Table 1 shows the relationship between dimensions, indicators, and items for each dimension.

Table 1
Relationship between dimensions, indicators, and items in the questionnaire. Own elaboration

Dimension	Indicator	Code	Items
(A) General General Student Information	(A.1) Personal	ECC	Which gender do you identify with?
	(A.2) Academic	NEC	Educational Level
		NST	What grade did you get in mathematics in the second term?
	(A.3) Economic	NEF	What do you think about your family's economic level?
(E) ICT and Mathematics Learning	(E.1) Resources home	RTC	Do you use the technological resources you have at home to study mathematics?
	(E.2) Contribution Perceived	TTM	Do you think that ICT helps you work harder and better at maths?
		TMN	Do you think ICT helps you improve your maths grades?
	(E.3) Tasks	ATC	Does your teacher assign activities, homework or projects for you to do using ICT?
(F) Cooperation	(F.1) Communication/ Collaboration	CIC	Do you share educational information and content with your classmates on social media and chat groups?
		CPI	I communicate with teachers via the internet: email, forums, instant messaging, chats, etc.
		CCI	I communicate with my classmates via the Internet: email, forums, instant messaging, chats, etc.

Note. Response options for each item: ECC = female, male; NEC = 1st year of secondary school, 2nd year of secondary school, 3rd year of secondary school, 4th year of secondary school, 1st year of sixth form, 2nd year of sixth form; NST = *insufficient, sufficient, good, very good, excellent*; NEF = *very low, low, high, very high*; RTC = *yes, no*; ATC = *never, sometimes, often, always*; TTM/TMN/CCI/CPI/CIC = *none, little, quite a lot, a lot*.

2.3. Data analysis

Statistical analyses were performed using the e1071 package from RStudio (Dimitriadou et al., 2009), considering the TMN item as the dependent variable and the rest as independent variables.

To address objective OE1, a Bayesian analysis was performed using contingency tables (Tables 2-4), calculating conditional probabilities. This initial exploratory approach allowed us to identify general patterns and analyze how students' perceptions of the contribution of ICT (TMN) to mathematics grades vary according to the study variables.

On the other hand, objective OE2 was analyzed using ordinal logistic regression, evaluating how the independent variables predict the different degrees of perception of ICT (TMN). B coefficients, standard errors, p values, odds ratios (OR) and 95% confidence intervals (Wald) were estimated. The model was adjusted with a pseudo-R-squared and significance $p < 0.05$, identifying key predictive factors and delving deeper into the relationships between variables.

Finally, for objective OE3, a discriminant analysis was performed with Wilks' Lambda, determining which independent variables significantly discriminate between TMN groups. Means, standard errors, standardized canonical coefficients and model classifications were calculated. In addition, visual representations of the canonical discriminant analysis were generated, and *post hoc* comparisons were applied with the Adonis algorithm, consolidating the identified relationships and highlighting key discriminant variables.

3. Results

The main findings are presented below. According to the Bayesian analysis, 22.37% of students consider that ICT does not contribute *at all* to improving their mathematics grades (TMN), 30.24% perceive *little* contribution, 30.94% *perceive considerable contribution*, and 16.43% *perceive significant contribution*. Tables 2-4 show the conditional probabilities of TMN based on the items in dimensions A, E, and F.

Table 2

Bayesian study. Conditional probability. (TMN: Perceived Contribution of ICT to Passing Mathematics) / Items from Dimension A. Own elaboration

Conditional Probability (%)					
P(TMN∣ECC: Gender)					
	Male		**Female**		
None	22,03		22,67		
A little	28,81		31,50		
Quite	31,56		30,39		
Very	17,58		15,42		
P(TMN∣NEF: Family Economic Level)					
	Very low	**Low**	**High**	**Very high**	
None	35,71	25,44	20,54	21,05	
A little	17,85	32,50	30,49	24,34	
Quite	26,78	28,09	32,66	28,94	
Very	19,64	13,95	16,29	25,65	
P(TMN∣NST: Grades)					
	Insufficient	**Satisfactory**	**Good**	**Very good**	**Excellent**
None	24,22	20,33	16,99	22,70	29,16
A little	28,44	32,53	32,86	29,47	27,91
Quite	32,84	29,18	30,91	32,53	26,66
Very	14,49	17,94	19,22	15,28	16,25

→

P(TMN∣NEC: Nivel Educativo)						
	1st year of secondary school	**2nd year of secondary education 3**	**ESO**	**4th year of secondary education**	**1st Year of Sixth Form**	**2nd Bach**
None	21,90	22,80	24,05	23,38	18,18	20,77
A little	31,66	31,79	31,13	25,77	31,60	28,57
Quite	26,66	28,66	29,36	36,27	34,63	36,36
Very	19,76	16,73	15,44	14,55	15,58	14,28

Table 2 shows that males are more likely to perceive that ICT contributes *quite a lot* (31.56%) or *a lot* (17.58%) compared to females (30.39% and 15.42%), who are more likely to perceive *no* (22.67%) or *little* (31.50%) contribution. According to socioeconomic status, students from lower socioeconomic backgrounds are more likely to perceive *no* (35.71%) or *little* (32.50%) contribution, while those from *very high* socioeconomic backgrounds perceive greater contribution (25.65%). Regarding grades, students with *insufficient* and *notable* grades are more likely to perceive a *significant* contribution (32.84% and 32.53%), while those with *outstanding grades* perceive a lower contribution (29.16%). In terms of educational level, sixth form students are more likely to perceive a *significant* contribution (34.63% and 36.36%), while secondary school students tend to perceive *little contribution* (31.13% to 31.79%, depending on the year).

Table 3

Bayesian study. Conditional probability. (TMN: Perceived Contribution of ICT to Passing Mathematics) / Items from Dimension E. Own elaboration

Probabilidad Condicionada (%)				
P(TMN∣TTM: Perceived Usefulness for Working with Mathematics)				
	None	**A little**	**Quite**	**Very**
None	86,64	11,18	3,71	4,23
A little	9,82	65,80	21,88	4,23
Quite	2,51	19,77	62,80	17,58
Very	1,00	3,24	11,58	73,94
P(TMN∣RTC: Home ICT Resources)				
	No		**Yes**	
None	38,33		13,28	
A little	30,15		30,30	
Quite	21,69		36,20	
Very	9,82		20,20	
P(TMN∣ICT Activities and Tasks)				
	Not at all	**A little**	**Quite a lot**	**A lot**
None	29,17	16,50	12,81	17,51
A little	29,27	37,42	27,75	20,73
Quite	28,07	32,24	38,79	30,87
Very	13,48	13,81	20,64	30,87

According to Table 3, students who work much harder and better at mathematics with ICT (TTM) are highly likely to perceive that ICT contributes *greatly* to improving their grades (73.94%); conversely, students who do not work harder and better are more likely not to perceive any contribution (86.64%). In terms of ICT use at home (RTC), the likelihood of perceiving *a significant* or *considerable* contribution is higher among those who do use it (36.20% and 20.20%) compared to those who do not (21.69% and 9.82%). Furthermore, the probability of perceiving *no* contribution is low among those who do use them (13.28%). Regarding the assignment of activities requiring ICT (ATC), the results show that the probability of perceiving a *high* contribution is greater when the teacher assigns many activities (30.87%) than when they assign *few* (13.81%) or *none* (13.48%).

Table 4
Bayesian study. Conditional probability. (TMN: Perceived Contribution of ICT to Passing Mathematics) / Items from Dimension F. Own elaboration

Conditional Probability (%)				
P(TMN∣CCI: Sharing Digital Information)				
	None	**A little**	**Quite**	**A lot**
None	40,96	20,59	15,53	20,00
A little	27,40	36,99	30,61	23,02
Quite	19,20	30,54	38,15	30,00
Very	12,42	11,86	15,68	26,97
P(TMN∣CPI: Digital Communication with Teaching Staff)				
	None	**A little**	**Quite**	**A lot**
None	26,04	20,14	10,13	5,40
A little	30,82	33,98	25,80	12,16
Quite	29,61	31,79	41,93	17,56
Very	13,51	14,07	22,11	64,86
P(TMN∣CIC: Digital Communication among Students)				
	None	**A little**	**Quite**	**A lot**
None	32,74	18,94	11,97	13,74
A little	31,61	34,30	27,23	19,90
Quite	23,33	35,15	40,61	28,43
Very	12,29	11,60	20,18	37,91

As shown in Table 4, the probability of perceiving a *significant* contribution from ICT is higher among students with a high level of digital interaction (26.97%) compared to those who interact *little* (11.86%) or *not at all* (12.42%). While those who interact *quite a lot* are highly likely to perceive a *significant* contribution (38.15%), those who interact *little* or *not at all* are more likely to perceive *little* or *no* contribution (36.99% and 20.59%; 27.40% and 40.96%). In terms of digital communication with teachers (CPI), students with a lot of digital interaction are more likely to perceive *a lot of* contribution (64.86%) compared to those who interact *little* (14.07%) or *not at all* (13.51%). Regarding the exchange of educational content via the internet (CIC), the probability of perceiving *a high* or *fairly* high contribution is greater among students who share a lot of information (37.91% and 28.43%) compared to those who share *little* (11.60% and 35.15%) or *nothing* (12.29% and 23.33%).

The ordinal logistic regression model was significant ($X2$= 2028.26, $p < 0.001$), explaining 67.5% ($R2$= 0.675) of the categories of the dependent variable (TMN).

These results highlight the predictive role of variables such as gender, domestic use, and perception of effective work with ICT. Table 5 contains the prediction values and ORs of the ordinal logistic regression model.

Table 5
Prediction Values and OR Values of Ordinal Logistic Regression. Own elaboration

TMN	*B(ES)*	*p*	95% CI for OR			TMN	*B(ES)*	p	95% CI for OR		
			Odds Ratio	Lower	Higher				Odds Ratio	Inferior	Superior
ECC=0	–0,21(0,10)	0,028	0,81	0,67	0,98	TTM=1	–7,93(0,25)	0,000	0,00	0,00	0,00
NEC=1	0,01(0,25)	0,958	1,01	0,62	1,66	TTM=2	–4,50(0,19)	0,000	0,01	0,01	0,02
NEC=2	0,02(0,25)	0,921	1,02	0,63	1,66	TTM=3	–2,70(0,17)	0,000	0,07	0,05	0,09
NEC=3	–0,14(0,25)	0,561	0,87	0,53	1,41	ATC=1	–0,37(0,17)	0,031	0,69	0,50	0,97
NEC=4	–0,03(0,25)	0,887	0,97	0,60	1,57	ATC=2	–0,35(0,18)	0,045	0,70	0,50	0,99
NEC=5	–0,06(0,26)	0,806	0,94	0,57	1,55	ATC=3	–0,04(0,20)	0,848	0,96	0,66	1,41
NST=1	0,10(0,17)	0,568	1,10	0,79	1,53	CCI=1	–0,32(0,17)	0,066	0,73	0,52	1,02
NST=2	0,08(0,17)	0,642	1,08	0,77	1,53	CCI=2	0,01(0,15)	0,955	1,01	0,76	1,35
NST=3	0,17(0,18)	0,327	1,19	0,84	1,69	CCI=3	0,03(0,14)	0,823	1,03	0,78	1,36
NST=4	0,17(0,17)	0,313	1,19	0,85	1,66	CPI=1	–0,91(0,33)	0,006	0,40	0,21	0,77
NEF=1	0,18(0,34)	0,594	1,20	0,61	2,35	CPI=2	–0,99(0,34)	0,003	0,37	0,19	0,72
NEF=2	–0,04(0,20)	0,851	0,96	0,65	1,43	CPI=3	–0,68(0,35)	0,050	0,51	0,26	1,00
NEF=3	0,03(0,19)	0,891	1,03	0,71	1,48	CIC=1	–0,34(0,19)	0,079	0,71	0,49	1,04
RTC=0	–0,60(0,10)	0,000	0,55	0,45	0,67	CIC=2	–0,27(0,19)	0,165	0,77	0,53	1,12
						CIC=3	–0,23(0,20)	0,245	0,79	0,54	1,17

Note: Variables whose *B* coefficient has been set to 0 have been excluded from the table: EEC = 1, NEC = 6, NST = 5, NEF = 4, RTC = 1, TTM = 4, ATC = 4, CCI = 4, CPI = 4, CIC = 4.

Among the most relevant findings, it was identified that gender has a statistically significant effect on the perception of ICT (ECC = 0, B = –0.21, p = 0.028), indicating that female students are 19% less likely to consider them useful (OR = 0.81, 95% CI [0.67 - 0.98]). Less use of ICT at home also had an influence (RTC = 0, B = –0.60, p < 0.001), reducing the likelihood of perceiving them as beneficial by 45% (OR = 0.55, 95% CI [0.45 - 0.67]). The perception of working better with ICT (TTM) proved to be the strongest predictor of the perception of its academic impact. The coefficients obtained for TTM levels reflect a clear trend: those who consider that ICT does not help them to work more and better in mathematics (TTM = 1, B

= –7.93, p < 0.001) have a virtually zero probability (OR = 0.00) of perceiving a positive contribution from these technologies. Similarly, those who report low (TTM = 2, B = –4.50, p < 0.001) or moderate (TTM = 3, B = –2.70, p < 0.001) usefulness also show drastic reductions in the probability of perceiving improvements in their academic performance.

Another relevant factor is the assignment of ICT tasks (ATC), where the absence of school activities requiring technology (ATC = 1, B = –0.37, p = 0.031) or an occasional assignment (TTA = 2, B = –0.35, p = 0.045) decrease the perceived usefulness of these tools (OR = 0.69 and OR = 0.70, respectively). On the other hand, digital communication with teachers (DCT) also emerged as a determining factor. Those who rarely interact digitally with their teachers (CPI = 1, B = –0.91, p = 0.006) or do so moderately (CPI = 2, B = –0.99, p = 0.003) are significantly less likely (OR = 0.40 and OR = 0.37, respectively) to perceive ICT as a beneficial resource for their learning.

Finally, the variables associated with educational level (NEC), previous grades (NST) and family economic level (NEF) did not have a significant effect on the regression, as their confidence intervals include the value 1 and the p-values are greater than 0.05.

Table 6 presents the results of the discriminant analysis using Wilks' Lambda criterion, indicating the ability of each variable to differentiate between groups of perception on the contribution of ICT in mathematics (TMN).

Table 6

Wilks' Lambda criterion for TMN. Own elaboration

Step	Input	Statistic	Wilks' lambda = Λ			
			F	gl1	gl2	p
1	TTM	0,415	946,18[a]	3	2016	< 0,001
2	RTC	0,400	390,24[a]	6	4030	< 0,001
3	CPI	0,394	253,92[b]	9	4901,69	< 0,001
4	NEC	0,391	188,96[b]	12	5326,18	< 0,001

Note. [a] Exact F. [b] Approximate F.

All variables included in the model are statistically significant ($p < 0.001$), confirming their relevance in the classification of groups. The analysis was performed in four steps, incorporating a new variable at each stage. In the first step, TTM (working better with ICT) showed the greatest discriminating impact ($\Lambda = 0.415$, $F = 946.18$), indicating that it is the most relevant predictor. In the second step, RTC (use of ICT at home) reduced Lambda to 0.400 ($F = 390.24$), demonstrating its importance in differentiating the groups. In the third step, CPI (digital communication with teachers) decreased Λ to 0.394 ($F = 253.92$). Finally, NEC (educational level), although with a lesser effect ($\Lambda = 0.391$, $F = 188.96$), remains significant.

To distinguish between predefined groups based on a linear combination of two or more independent variables, canonical discriminant analysis is used (see Figure 2).

Figure 2 shows that the TMN variable takes more than two factors. Therefore, the optimal option is to use multiple *post hoc* comparisons through the Adonis algorithm with 49 permutations. The results reveal the existence of statistically significant differences between all TMN levels. The items with the greatest influence on TMN are TTM and, to a lesser extent, RTC, ATC, CCI, CPI, and CIC. In other words, in addition to the perceived usefulness of ICT for studying mathematics, the use of ICT resources for academic purposes, the completion of tasks with ICT, communication between students and teachers, and the exchange of digital academic information also have an influence.

In relation to educational level (NEC) and economic level (NEF), Figure 2 reveals a positive, albeit not statistically significant, association between these variables and the perceived contribution of ICT to performance (TMN). In contrast, the findings suggest that gender (ECC) and mathematics scores (NST) have a statistically insignificant negative impact on TMN variability.

4. Discussion and conclusions

The present study aims to analyze the factors that influence the perceived usefulness of ICT in secondary school students in Melilla for learning mathematics, considering sociodemographic, academic and digital interaction variables. The results show the influence of gender, socioeconomic status, ICT use at home, ICT-based activities and digital communication. These determinants reflect structural and contextual dynamics that influence access to and use of technologies during the mathematics learning process.

In terms of gender, the results suggest that female students perceive a lower contribution of ICT to learning than male students and provide a contextual perspective when analyzing how these dynamics operate in a multicultural environment that influences gender perception (Arredondo-Trapero et al., 2021; Aruleba et al., 2023). This result, consistent with previous research, could be associated with a self-perception of lower digital competence derived from gender stereotypes (Siddiq and Scherer, 2019), but also with contexts where female students have fewer opportunities to experiment and become familiar with technological tools (Nino-Cortés et al., 2023). This result could be interpreted as a reflection of persistent sociocultural barriers in unique geographical environments such as Melilla. Therefore, it is necessary to propose interventions that promote equal opportunities, such as technological training programs focused on closing these gaps.

On the other hand, the findings indicate that students from lower economic backgrounds have a lower perception of the impact of ICT on their performance. Along the same lines, other studies highlight that unequal access to devices and quality connections can amplify educational inequalities (Dodel, 2022). The observed relationship between technological resources and perceptions of usefulness is explained by the frequency and quality of use of these tools: a family environment without adequate access, with limited access, restricts autonomous exploration and the integration of ICT in learning (Erdogdu and Erdogdu, 2015).

Regarding the use of digital technologies at home, the results show that their use is associated with a more positive perception of the contribution of these technologies to mathematics learning. This finding is consistent with the literature that highlights how frequent use in non-school contexts encourages self-directed learning and develops digital skills (Skvarc et al., 2021).

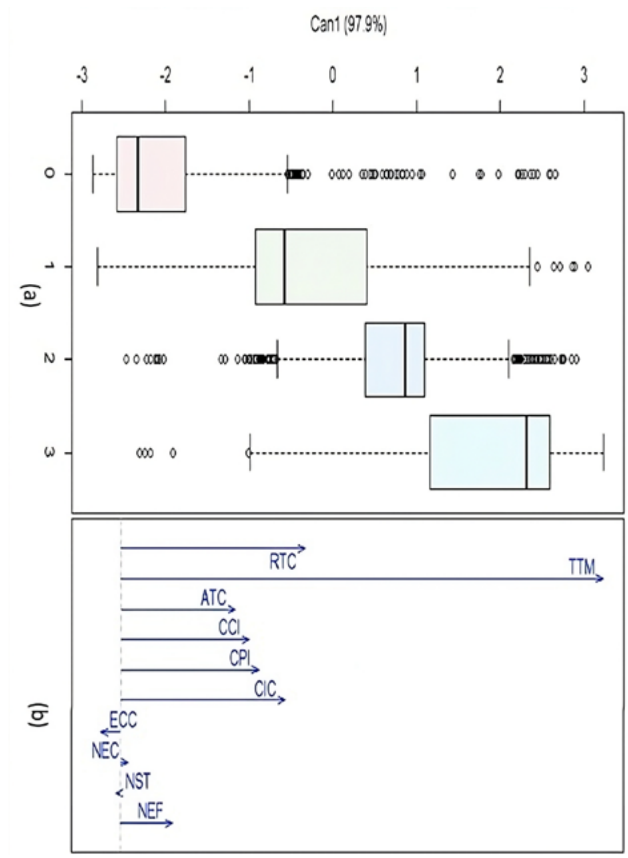

Figure 2. *LDA for the TMN variable. Own elaboration*
Note**.** *LDA values; (a) Canonical score; (b) Vector.*

Regarding the assignment of activities, there is a significant association between the frequency with which teachers assign activities that require the use of ICT and more positive perceptions by students about the usefulness of these technologies in mathematics. This highlights the role of teachers as facilitators in the integration of technologies into learning (Botuzova, 2020), as well as their role as mediators in the use of ICT. In fact, the assignment of ICT activities and digital communication are associated with more positive perceptions, suggesting their potential to mitigate, to some extent, inequalities external to the education system. This coincides with studies that emphasize the importance of institutional policies to strengthen teachers' digital competence (García-Vandewalle et al., 2023) and ensure the effective integration of ICT into school curricula (Carvalho and Santos, 2020). However, it also points to the need to design pedagogically meaningful activities that promote active learning through ICT.

About digital communication and interaction with teachers and peers, the results suggest that it is associated with more positive perceptions of the impact of ICT. This result is consistent with other studies that show how digital communication improves access to teaching resources, continuous feedback and peer collaboration (Bond, 2020; Sipilä, 2014). In contexts such as Melilla, these digital interactions seem to be associated with a reduction in cultural and linguistic barriers, strengthening collaborative learning.

The findings of this study highlight the need for comprehensive education policies that guarantee equitable access to ICT, especially in socioeconomically vulnerable contexts in Melilla, where digital divides perpetuate gender and economic inequalities. This implies adequate technological provision, technological training for students and families, teacher training for the effective integration of ICTs into curricula and the design of meaningful pedagogical activities, encouraging student participation. In addition, digital divides and gender stereotypes must be addressed, using ICTs to strengthen communication and educational collaboration.

In conclusion, this study achieved its overall objective of analyzing how secondary school students in Melilla perceive the contribution of ICT to mathematical learning, identifying the variables that influence these perceptions and providing evidence for the design of inclusive educational policies. In relation to objective OE1, gender and socio-economic status were identified as key factors: female students perceive a lower contribution from ICT, a result that could be associated with socio-cultural barriers identified in previous studies, while students from lower-income families show less access to and perception of the impact of these tools. The use of ICT at home and the frequent assignment of tasks involving technology are associated with more positive perceptions. For objective OE2, logistic regression showed that working better with ICT, gender and domestic use are the most relevant predictors. In objective OE3, discriminant analysis showed that the perception of usefulness and digital interaction differentiate levels of perception.

The limitations of the study include its non-experimental design, the use of dichotomous variables, and the localized sample, which limits generalization. In particular, the variable on access to ICT at home was analyzed dichotomously (yes/no), which may have simplified the reality of its use and limited the identification of nuances in its perceived impact. Furthermore, it is important to note that the perceptions studied do not necessarily reflect the actual impact of ICT on academic performance. To address these limitations, future research could benefit from longitudinal approaches and qualitative methodologies (interviews, case studies, etc.) to gain a deeper understanding of the specific perceptions, experiences, and barriers that students encounter in their daily use of digital technologies.

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