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Language teachers' perceptions and acceptance of educational robotics for classroom integration

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ABSTRACT

Robotics education and robot-embedded learning have become focal points in recent interdisciplinary and innovative education. Despite the identified opportunities, there are still limitations and considerations before integrating educational robotics into foreign language education on a large scale. This survey investigates foreign language teachers' perceptions and acceptance of teaching with educational robotics and robot-assisted language learning. To achieve this, the ERPA scale, containing five subscales measuring teachers' technological, pedagogical, and content knowledge, and the perceived usefulness of robots, was adapted as the data collection instrument. The scale consisted of 19 items based on a 5-point Likert scale. A total of 109 foreign language teachers from Spain participated in the survey. The results suggest a positive relationship between teachers' basic digital competence, technological knowledge of robot usage, pedagogical knowledge in foreign language teaching, and perceived usefulness of robots. Additionally, the length of service and target language positively affect acceptance. This research contributes to current educational robotics studies by identifying features of robots considered suitable for language teaching, such as animal-like embodiments instead of humanoid forms.

Keywords: attitudes, acceptance, educational robotics, EFL, second language

INTRODUCTION

Recent developments in educational robotics have highlighted the need to explore attitudes toward this technology for mass-market implementation in educational institutions. At the current stage, robot-assisted learning, or learning embedded with robots, has experienced a gradual transition from a concept rooted in science fiction to a prevalent global educational practice as a consequence of the persistent effort of roboticists, educators, and psychologists (Reich-Stiebert & Eyssel, 2016).

Researchers and educators have identified the potential of educational robotics (Arís & Orcos, 2019). The primary reason that robots are considered to have a positive impact on education is that children appear to be more engaged in the learning process (Chin et al., 2014). Additionally, social robots can mimic human responses, making them more effective teaching aids than computers or other technological instructional tools (Tuna & Tuna, 2019).

Robotics is directly linked to STEM education (Eguchi & Uribe, 2017). Researchers have identified that the anticipated learning outcomes extend beyond the acquisition of content knowledge as seen with traditional learning, to include improvements in students' behavioral, social, scientific, cognitive, and intellectual attitudes and skills (Latip et al., 2020; Rahman, 2021). Beyond STEM education, educational robotics has also been successfully integrated into assisting language learning, interdisciplinary learning, and special education (Lin et al., 2022; Pei & Nie, 2018; Van den Berghe et al., 2019; Yu et al., 2024).

The rise of new information and communication technology (ICT) tools has piqued teachers' interest in how to use them in the classroom (Molnár & Szűts, 2022). While educational robots are beneficial, there are still some challenges, including gender issues, teacher challenges, technical difficulties, and resource constraints (Pei & Nie, 2018).

As this field of research advances, and if we seek further real-world or mass-market implementation in schools, it is important to understand users' perceived usefulness and acceptance of this technology. This paper aims to explore whether, when minimal context is provided, teachers' acceptance of using this technology in foreign language classrooms is achieved and to understand their perceptions of useful robot design (RD).

RELATED WORK

Teachers play an indispensable role in education and their opinions shape educational goals, instructional techniques, and learning results. When teachers believe that technology is valuable, they are more likely to incorporate it into their teaching practices (Ottenbreit-Leftwich et al., 2010).

Both personal and extrinsic barriers have been identified when technology is to be adopted and used by teachers. Internally, a variety of issues that teachers confront when integrating technology have also been noted. Betancourt-Odio et al. (2021) believe that the under-use of technology in classrooms may be due to a failure to provide pre-service teachers with both technological skills and the technique for incorporating technology into the curriculum, rather than just technology knowledge. Similarly, a qualitative study carried out by Park and Son (2022) reveals that pre-service teachers in Hongkong demonstrate low motivation, limited adoption, and application in implementing technology in their lessons despite their high level of confidence in technology integration skills.

Surveys such as that conducted by Lai Wah and Hashim (2021) have shown that Malaysian TESL undergraduates' usage of technology for teaching ESL was significantly influenced by technological, pedagogical, and content knowledge (TPACK). TPACK emphasizes that instructors' use of technology includes not only technological knowledge and skills but also technological knowledge and skills in relation to target content and matching pedagogy (Park & Son, 2022). Furthermore, TPACK has been established as a framework for teachers' integration of technology in their classrooms. Complementary to Lai Wah and Hashim (2021), a study by Mouza and Karchmer-Klein (2013) shows that teachers experienced significant improvements in all TPACK domains when they applied their teaching and knowledge in practice with technology.

Hunutlu and Küçük (2022) surveyed 170 English teachers whose workload and technostress are at a moderate level indicating that most English teachers are positive about TPACK, furthermore, those who use more web 2.0 tools have more positive perceptions of TPACK and less technostress. However, technology sometimes inevitably increases their workload.

Based on the findings with the TPACK framework, we propose our first two hypotheses:

H1: Teacher's basic digital competence (BC) is positively related to acceptance of active usage of educational robotics in classrooms.

H2: Teachers' knowledge of integrating robots in foreign language classrooms is positively related to acceptance of active usage of educational robotics in classrooms.

Regarding social robots, Saari et al. (2022) discovered that the general public perceived enjoyment significantly impacts their perception of usefulness. These findings suggest that an individual's innovation adoption style shapes the factors they deem important for the usefulness of social robots. The usefulness, social capability, and appearance of robots positively influence consumers' attitudes toward human-robot interaction. Favorable attitudes toward human-robot interaction predict higher anticipated service quality, which, in turn, positively affects the acceptance of humanoid retail service robots (Song & Kim, 2022). Regarding perceived robot usefulness in the foreign language education context, we formulated the following hypotheses:

H3: Perceived useful RD is positively related to the acceptance of active usage of educational robotics in classrooms.

H4: Perceived useful robot function (RF) is positively related to acceptance of active usage of educational robotics in classrooms.

H5: Social and emotional support (ES) and companionship from robots are positively related to the acceptance of active usage of educational robotics in classrooms.

Wang et al. (2023) called for teachers' acceptance of artificial intelligence (AI) technology to be scrutinized, given the prevalence of AI robots in the current trend. Up to now, no significant difference was found between teachers from different socio-economic regions and gender groups regarding AI readiness. But literature suggested that AI-ready teachers perceive low threats from AI while demonstrating a high level of AI-enhanced innovation, and are highly satisfied at work (Wang et al., 2023). Teo (2014) explored how demographic factors such as age, gender, education level, and prior experience with robots influence the acceptance of robotic assistance. A survey conducted by Teo (2014) on 673 primary and secondary teachers revealed significant gender disparities in perceived ease of use, with male teachers scoring higher than female teachers. Additionally, statistically significant differences were found in perceived ease of use and attitudes toward technology use between teachers with varying years of teaching service.

Based on the literature regarding individual differences, the following hypothesis was formulated:

H6: Age does not significantly affect foreign language teachers' perceived usefulness and acceptance of active usage of educational robotics in classrooms, other variables related to age such as Service length might explain the influence.

Teachers' willingness to incorporate technology is also influenced by external factors, including school issues and culture, which have been identified as significant obstacles (Lai Wah & Hashim, 2021; Lai et al., 2022). Specifically, factors like costs, preparation time, and the omnipresence of technology in today's society contribute to teachers' reluctance to integrate it into their classrooms (Negrini, 2020). Moreover, teachers encounter difficulties in selecting suitable technology due to the multitude of options available, further complicating the decision-making process and requiring additional setup time (Lai Wah & Hashim, 2021).

Reich-Stiebert and Eyssel (2015) conducted a survey on attitudes toward education robots in the German context. Their results indicated that Respondents held a neutral attitude and could visualize applications for education robots in science, technology, engineering, and mathematics, but rejected them in arts and social sciences. This research answers Reich-Stiebert and Eyssel's (2015) call for more empirical evidence on the role of culture, robot type, and other predictors in shaping attitudes toward robots. In the Italian context, teachers' attitudes toward educational robotics were positive. Researchers found that these attitudes were not related to anxiety evoked by robotics but were positively related to several factors. These factors included positive attitudes about the use of robotics, perceptions that there are environmental factors facilitating the use of robotics, perceptions of the robots' adaptability, the enjoyment of using robotics, the belief that robotics will improve workplace performance, positive perceptions of others' views on robotics, and perceptions of robotics' integrity. This finding highlights the importance of considering specific predictors when examining attitudes toward educational robotics. These results indicate that ER may be more readily integrated into educational contexts as well as therapeutic and rehabilitation purposes, depending on teachers' interest in educational robotics and recognition of its potential for fostering transversal skills (Di Battista et al., 2021)

To overcome the challenges addressed above and promote successful technology integration, it is imperative to offer more technology-related courses tailored to the target language (Lai Wah & Hashim, 2021;

Palacios-Hidalgo & Huertas- Abril, 2022). Besides, the use of ICT and digital devices by FL teachers has received limited academic scrutiny, and much of the integration of technology is based on science education or the tertiary level, so there are few studies on teachers' perceptions and use of information technology in primary foreign language education (Spiteri & Chang Rundgren, 2020). The last two hypotheses were formulated regarding the education context, as follows:

H7: Level taught significantly affects foreign language teachers' perceived usefulness and acceptance of active usage of educational robotics in classrooms.

H8: The language taught significantly affects foreign language teachers' perceived usefulness and acceptance of active usage of educational robotics in classrooms.

The goal of this research was to determine the current use of technology in foreign language classrooms and investigate the factors influencing teachers' intention and belief toward its usage. This was done in order to acquire a better knowledge of the teaching and learning environment. In this investigation, a quantitative instrument was used to collect data on technology integration and the influential factors on integration. On the basis of the survey's general findings, an overview is offered.

METHODS

This study employed a quantitative approach using a self-administered online questionnaire as the main research instrument to evaluate the knowledge level of digital competence, acceptance, and perceived usefulness among foreign language teachers at diverse educational levels in Spain. The data were collected between March 10th and May 10th, 2024.

Data Collection

This study employed convenience and snowball sampling methods, both widely used in educational research when the target population is specialized or hard to reach, as in this case (Biernacki & Waldorf, 1981; Etikan et al., 2016). Convenience sampling allowed for the recruitment of teachers who were readily available and willing to participate. Furthermore, snowball sampling was utilized to expand the participant pool by reaching out to existing networks of respondents, which is an effective technique for accessing a broader population (Cohen et al., 2017).

These methods are appropriate when random sampling is not feasible, particularly when studying a specific group of teachers, whose participation is often constrained by availability and other external factors (Dörnyei, 2007). Although non-random, these techniques provide valuable insights into educators' perspectives and have been successfully applied in prior research on emerging educational technologies and attitudes (Cohen et al., 2017).

Instruments

An ERPA scale was previously developed and validated as an instrument for data collection. The ERPA has 5 subscales: BC, robot usage (RU), RD, RF, and ES. The Cronbach's alpha coefficient was computed for each of the consisting factors, namely, RD, RU, BC, RF, and ES. The reliability (alpha) coefficients for the five sub-factors were found to be .89, .89, .80, .83, and .61, respectively, and the overall alpha was 0.91 displaying acceptable reliability. The scale consisted of 19 items measured on a 5-point Likert scale, with factor loadings ranging from 0.582 to 0.879, suggesting acceptable validity.

The survey also gathered demographic information, including gender, age, teaching experience (service length), educational level taught, and target language. Participants were required to provide written informed consent before beginning the survey. Consent was obtained electronically by including an informed consent statement at the beginning of the survey, and participants could exit the survey at any time. Only those who agreed to participate could proceed with the questionnaire. The responses were anonymous, and the collected data were stored by researchers only for research purposes.

Participants

The final sample consisted of 109 foreign language teachers from Spain. General demography showed that 73.4% of the respondents were female (N = 29), leaving only 26.6 % males (N = 80). 52.3% of the

Table 1. Participant demographics

Characteristics		Frequency	Percentage (%)
Gender	Male	29	26.6
	Female	80	73.4
Age	21–30	57	52.3
	31–40	25	22.9
	41–50	15	13.8
	51–60	8	7.3
	61+	4	3.7
Service length	1–5 years	59	54.1
	6–10 years	21	19.3
	11–15 years	10	9.2
	16–20 years	6	5.5
	Over 20 years	13	11.9
Level taught	Preschool	6	5.5
	Primary school	34	31.2
	Secondary school	17	15.6
	High school	15	13.8
	Vocational training	7	6.4
	University	16	14.7
	Official school of languages	1	0.9
	Language academy	13	11.9
Language taught	Arabic	1	0.9
	Chinese	42	38.5
	Spanish	21	19.3
	French	1	0.9
	English	42	38.5
	Other	2	1.8

respondents were 21–30 years old. Additionally, the majority of respondents (54.1%) had 1–5 years of teaching experience, and most taught either English or Chinese as foreign languages (occupying 38.5% each). The majority of the respondents teach in formal education settings involving primary education (31.2%), secondary (15.6%), and tertiary level (14.7%), see **Table 1**.

Data Analysis

The survey data were analyzed using SPSS version 28.0. Descriptive statistics as to mean scores, standard deviations, and minimum-maximum values were reported to provide an overview of the participants' knowledge levels and perceptions across these dimensions. Inferential statistics such as Pearson correlation coefficients were computed to examine the relationships between the five subscales (BC, RU, RD, RF, and ES) and overall acceptance of educational robotics. This analysis aimed to test the strength of the relationships between variables. To further explore the predictors of teachers' acceptance of educational robotics, multiple regression analysis was performed. Acceptance was treated as the dependent variable, and the five dimensions (BC, RU, RD, RF, and ES) were entered as independent variables. Regression coefficients (B), standard errors (SEs), t-values, and variance inflation factors (VIF) were reported to assess the relative contribution of each predictor to the overall acceptance of educational robotics. The assumptions of the regression model were also checked, including linearity, normality, and homoscedasticity. Residual plots were examined to confirm that the residuals were randomly distributed, thus meeting the assumption of homoscedasticity. The model's goodness of fit was assessed using the R-squared value, which indicates the proportion of variance in acceptance explained by the independent variables.

Additionally, to examine demographic variables, one-way ANOVA tests were conducted to examine whether age, service length, level taught, and language taught significantly affected the acceptance and perceived usefulness of educational robotics. finally, an independent samples t-test was conducted to compare acceptance, perceived usefulness, and TPACK (technological pedagogical and content knowledge) between male and female teachers. Differences were considered significant at $p < 0.05$.

Table 2. Descriptive statistics on the 5 subscales

	Mean	Minimum	Maximum	SD	N
BC	3.77	1.75	5	0.80	109
RU	2.76	1.00	5	1.07	109
RD	3.53	1.43	5	0.82	109
RF	3.81	1.50	5	0.79	109
ES	3.31	1.00	5	0.99	109

Table 3. Correlation analysis

	BC	RU	RD	RF	ES	Acceptance
BC	1					
RU	.418**	1				
RD	.305**	.542**	1			
RF	.219*	.450**	.690**	1		
ES	.235*	.582**	.618**	.453**	1	
Acceptance	.564**	.825**	.831**	.730**	.789**	1

* Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

Table 4. Regression analysis for BC and RU

	B	SE	B	t	p	VIF
(Constant)	1.350	0.163		8.265	< 0.05	
BC	0.224	0.046	0.266	4.856	< 0.05	1.212
RU	0.449	0.034	0.713	13.036	< 0.05	1.212
R^2	0.738					
F	149.351					
p	< 0.05					

RESULTS

Descriptive statistics on the 5 subscales suggest that the RU scale which assesses teachers' TPACK regarding educational robotics in language learning, appears to be the weakest among the 5 subscales, with a mean score of 2.76. Additionally, the SE of 1.07 is comparatively larger than other dimensions, suggesting larger variability in teachers' knowledge levels in this respect, see **Table 2**.

To test our hypotheses **H1** to **H5**, firstly a correlation analysis was conducted to examine the relationships between BC, RU, RD, RF, ES, and overall acceptance. The results of correlation analysis are presented in **Table 3**. The results revealed that the five dimensions ($r_{BC} = 0.564$, $r_{RU} = 0.825$, $r_{RD} = 0.831$, $r_{RF} = 0.730$, $r_{ES} = 0.789$, $p < 0.01$) are all significantly correlated with acceptance, supporting hypotheses **H1**-**H5**.

Secondly, to further validate **H1**-**H5**, multiple regression analysis was conducted with Acceptance as the dependent variable, and BC, RU, RD, RF, and ES as independent variables. **Table 4** shows regression analysis for BC and robotics-related technological, and pedagogical knowledge for language teaching.

The regression analysis results indicated that BC and RU had a significant positive effect on Acceptance, further supporting hypotheses **H1** and **H2**. Specifically, BC ($B = 0.266$, $p < .05$) and RU ($B = 0.713$, $p < .05$), suggest the prediction that the higher teacher's BC and TPACK are, the higher their Acceptance for educational robotics and robot embedding foreign language learning. Additionally, residuals in **Figure 1** reveal a random distribution, indicating the assumption of homoscedasticity is met which supports the validity of the linear regression model.

Hypotheses **H3**, **H4**, and **H5** were also supported, indicating significant positive relationships between perceived usefulness (RD, RF, and ES), and acceptance (**Table 5**). Specifically, RD ($B = 0.371$, $p < .05$), RF ($B = 0.237$, $p < .01$), and ES ($B = 0.434$, $p < .05$) all contribute to a greater likelihood of acceptance when diverse RDs, functions, and ES are provided.

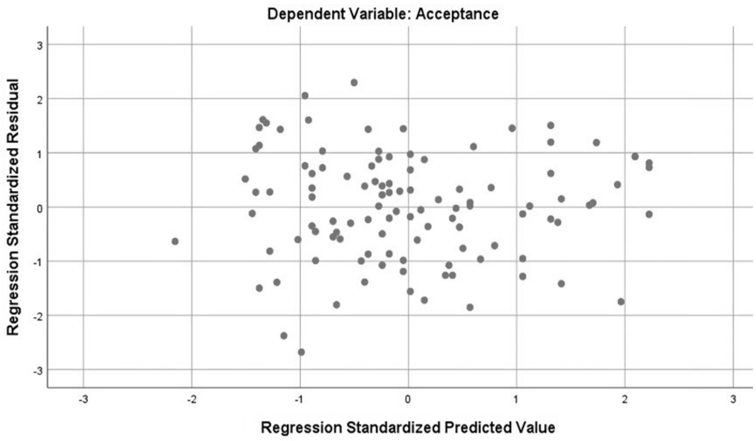

Figure 1. TPACK scatterplot (Source: Authors' own elaboration)

Table 5. Regression analysis on perceived usefulness

	B	SE	B	t	p	VIF
(Constant)	0.478	0.130		3.680	< 0.05	
RD	0.303	0.048	0.371	6.345	< 0.05	2.461
RF	0.237	0.044	0.277	5.365	< 0.05	1.915
ES	0.298	0.033	0.434	9.146	< 0.05	1.620
R^2	0.854					
F	204.348					
p	< 0.05					

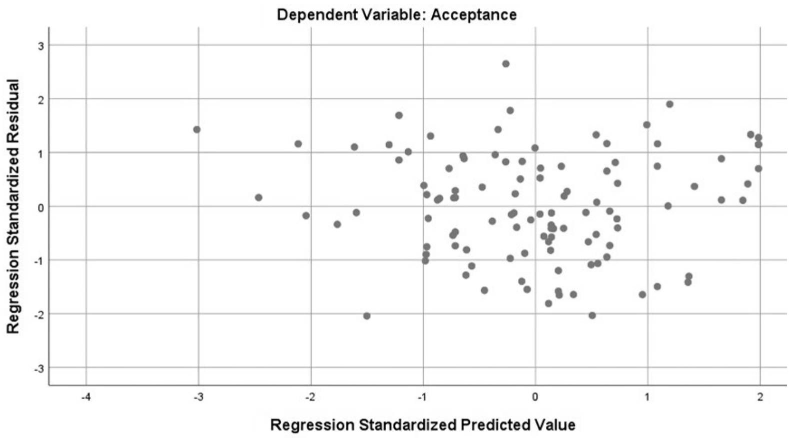

Figure 2. Perceived usefulness scatterplot (Source: Authors' own elaboration)

Table 6. Independent samples t-test results for gender differences

Variables	Male (N = 29)	Female (N = 80)	Diff (95% confidence interval)	t	p
Acceptance	3.63 ± 0.75	3.36 ± 0.63	0.26 (–0.02, 0.55)	1.81	0.07
Usefulness	3.75 ± 0.80	3.47 ± 0.70	0.27 (–0.04, 0.58)	1.71	0.09
TPACK	3.45 ± 0.82	3.20 ± 0.77	0.25 (–0.09, 0.58)	1.45	0.15

Demographic Factors

An independent samples t-test was conducted to compare the acceptance of educational robotics, perceived usefulness, and TPACK (BC and RU) between male and female teachers.

The results indicated that there were no statistically significant differences between male and female language teachers in terms of acceptance of educational robotics (t [109] = 1.81, p = 0.07), perceived usefulness (t [109] = 1.71, p = 0.09), and TPACK (t [109] = 1.45, p = 0.15) (see **Table 6**). One-way ANOVA tests were conducted to test hypotheses **H7** to **H10**, examining whether age, service length, level taught, and language taught significantly affect foreign language teachers' perceived usefulness and acceptance of educational robotics in classrooms. The ANOVA results for acceptance and perceived usefulness are presented in **Table 7** and **Table 8**, respectively.

Table 7. ANOVA results for acceptance

Variables	Groups	Mean	SD	95% confidence interval		F	p
				LB	UB		
Age	21–30	3.46	0.68	3.28	3.64	0.93	0.45
	31–40	3.59	0.68	3.31	3.87		
	41–50	3.26	0.64	2.91	3.62		
	51–60	3.29	0.55	2.83	3.76		
	60+	3.10	0.79	1.84	4.37		
	Total	3.44	0.67	3.31	3.56		
Service length	1–5 years	3.44	0.67	3.26	3.61	3.30	0.01
	6–10 years	3.69	0.59	3.42	3.96		
	11–15 years	3.70	0.63	3.24	4.15		
	16–20 years	3.16	0.60	2.53	3.80		
	20+ years	2.95	0.63	2.57	3.33		
	Total	3.44	0.67	3.31	3.56		
Level taught	Preschool	3.89	1.10	2.74	5.05	1.16	0.33
	Elementary school	3.47	0.62	3.25	3.68		
	Middle school	3.32	0.58	3.02	3.62		
	High school	3.66	0.65	3.30	4.01		
	Vocational training	3.47	0.80	2.74	4.21		
	University	3.36	0.79	2.94	3.78		
	Official language school	2.89					
	Language academy	3.16	0.41	2.91	3.41		
	Total	3.44	0.67	3.31	3.56		
Language taught	Arabic	4.30				2.73	0.02
	Chinese	3.47	0.67	3.26	3.68		
	Spanish	3.03	0.54	2.79	3.28		
	French	3.20					
	English	3.61	0.68	3.39	3.82		
	Other	3.08	0.06	2.50	3.65		
	Total	3.44	0.67	3.31	3.56		

Table 8. ANOVA results for perceived usefulness

Variables	Groups	Mean	SD	95% confidence interval		F	p
				LB	UB		
Age	21–30	3.58	0.75	3.38	3.78	0.57	0.69
	31–40	3.65	0.74	3.34	3.96		
	41–50	3.31	0.76	2.89	3.74		
	51–60	3.44	0.54	2.98	3.89		
	60+	3.60	0.86	2.24	4.96		
	Total	3.55	0.73	3.41	3.69		
Service length	1–5 years	3.57	0.74	3.38	3.76	1.65	0.17
	6–10 years	3.70	0.67	3.40	4.01		
	11–15 years	3.79	0.65	3.33	4.26		
	16–20 years	3.17	0.65	2.49	3.85		
	20+ years	3.21	0.83	2.71	3.71		
	Total	3.55	0.73	3.41	3.69		
Level taught	Preschool	3.88	1.07	2.76	5.01	1.06	0.40
	Elementary school	3.61	0.71	3.36	3.85		
	Middle school	3.39	0.68	3.04	3.73		
	High school	3.84	0.58	3.52	4.16		
	Vocational training	3.53	0.82	2.77	4.29		
	University	3.47	0.92	2.98	3.96		
	Official language school	2.85					
	Language academy	3.29	0.53	2.97	3.61		
	Total	3.55	0.73	3.41	3.69		
Language taught	Arabic	4.31				2.12	0.07
	Chinese	3.55	0.69	3.33	3.77		
	Spanish	3.20	0.77	2.85	3.55		
	French	2.88					
	English	3.74	0.71	3.52	3.96		
	Other	3.13	0.19	1.47	4.79		
	Total	3.55	0.73	3.41	3.69		

Table 9. ANOVA results for TPACK

Variables	Groups	Mean	SD	95% confidence interval		F	p
				LB	UB		
Age	21–30	3.27	0.78	3.06	3.48	2.16	0.08
	31–40	3.51	0.75	3.20	3.81		
	41–50	3.18	0.75	2.77	3.60		
	51–60	3.08	0.82	2.40	3.77		
	60+	2.35	0.72	1.21	3.50		
	Total	3.27	0.79	3.12	3.42		
Service length	1–5 years	3.24	0.77	3.04	3.44	4.90	0.00
	6–10 years	3.66	0.70	3.34	3.98		
	11–15 years	3.56	0.74	3.03	4.09		
	16–20 years	3.15	0.78	2.33	3.97		
	20+ years	2.57	0.62	2.20	2.94		
	Total	3.27	0.79	3.12	3.42		
Level taught	Preschool	3.90	1.25	2.59	5.21	0.96	0.47
	Elementary school	3.25	0.71	3.01	3.50		
	Middle school	3.22	0.80	2.81	3.63		
	High school	3.38	0.90	2.88	3.88		
	Vocational training	3.39	0.79	2.66	4.12		
	University	3.21	0.88	2.74	3.67		
	Official language school	2.96					
	Language academy	2.96	0.35	2.74	3.17		
	Total	3.27	0.79	3.12	3.42		
Language taught	Arabic	4.29				2.56	0.03
	Chinese	3.35	0.80	3.10	3.60		
	Spanish	2.78	0.48	2.56	3.00		
	French	3.67					
	English	3.40	0.83	3.14	3.66		
	Other	3.00	0.12	1.94	4.06		
	Total	3.27	0.79	3.12	3.42		

The results suggest that service length $F(4, 104) = 3.30$, $p < 0.05$ and the language taught $F(3, 103) = 2.73$, $p < 0.05$ have significant effects on the acceptance of educational robotics among teachers, while age $F(4, 104) = 0.93$, $p > 0.05$ and teaching level $F(6, 101) = 1.16$, $p > 0.05$ do not. Post-hoc LSD analysis indicated that the mean score for the group with 20+ years of service was significantly lower than group of 1–5 years (MD = –.48, $p < 0.05$), group of 6–10 years (MD = 0.73, $p < 0.01$), group of 11–15 years (MD = 0.75, $p < 0.01$). Post-hoc analysis was not performed for language taught because French and Arabic have fewer than two cases.

Similarly, a one-way between subjects ANOVA was conducted on perceived usefulness, however, no significant effects of age $F(4, 104) = 0.57$, $p > 0.05$, service length $F(4, 104) = 1.65$, $p > 0.05$, teaching level $F(6, 101) = 1.06$, $p > 0.05$, or language taught $F(3, 103) = 2.12$, $p > 0.05$ on the perceived usefulness of educational robotics among teachers.

Additionally, ANOVA was conducted on the TPACK dimension as TPACK affect general acceptance. No significant effects of age $F(4, 104) = 2.16$, $p > 0.05$ and teaching level $F(6, 101) = 0.96$, $p > 0.05$ was found. Service length $F(4, 104) = 4.90$, $p < 0.01$ and language taught $F(3, 103) = 2.56$, $p < 0.05$ significantly affect teachers' TPACK (**Table 9**).

Post-hoc LSD analysis indicated that the mean score for the group with 20+ years of service was significantly lower than group of 1–5 years (MD = –0.67, $p < 0.01$), group of 6–10 years (MD = –1.10, $p < 0.01$), group of 11–15 years (MD = –0.99, $p < 0.01$). Post-hoc analysis could not be applied to target language due to insufficient respondents in specific groups.

Finally, a paired samples t-test was conducted to determine language teachers' ethical acceptance of using humanoid robots (mean [M] = 3.40, standard deviation [SD] = 1.07) and robots that resemble animals (M = 3.60, SD = 0.91) in the classroom. The result indicates that humanoid robots are less ethically accepted for foreign language classroom use than robots that resemble animals MD = –0.19, $t(108) = -2.41$, $p < 0.05$.

DISCUSSION

The objective of this research is to examine whether foreign language teachers, similar to science teachers, perceive the usefulness of educational robotics and to identify the factors that affect their acceptance of this technology for classroom use. This research also confirms the influence of sociodemographic variables on ER acceptance. These findings have theoretical implications for understanding how foreign language educators approach the integration of cutting-edge technologies into their teaching practices.

The correlation and regression analysis indicated that BC, RU, RD, RF, and ES significantly predict ER acceptance, confirming hypothesis H1-H5. These results align with the broader framework of TPACK (Lai Wah & Hashim, 2021), which emphasizes that a teacher's ability to integrate technology into pedagogy dependents on technical knowledge, and also dependents on their understanding of how to apply technology effectively in specific subject areas (Koehler et al., 2014). Furthermore, the role of ES and RD resonates with findings from previous studies on social robots, where the human-like interactions and emotional engagement of robots positively influenced attitudes toward technology adoption (Saari et al., 2022; Song & Kim, 2022). These aspects should be considered when considering the design and functionality of educational robots for language learning environments.

In terms of demographic factors, results obtained from this dataset suggest teachers with more than 20 years of service showed less acceptance could indicate a preference for traditional methods or a reluctance to adopt new technologies as it may causes changes to teachers' workload, as suggested in previous literature (Hunutlu & Küçük, 2022). These findings align with previous studies by Teo (2014), who also reported service length as a crucial factor. However, contrary to Teo (2014) and Wang et al. (2023), gender and age did not significantly affect acceptance in our sample. This discrepancy may result from differences in sample demographics and educational contexts, and it may also imply that other contextual factors, such as institutional culture or technological infrastructure, might mitigate the influence of teachers' age or gender in this context.

Regarding the language taught, teachers of different languages showed varying levels of acceptance of ER. Specifically, Chinese and English teachers demonstrated higher acceptance compared to those teaching Spanish or Arabic, which aligns with Yu et al.'s (2023) findings on the integration of robots in language learning. This might result from abundant digital resources available in these two languages or it suggests that language specificity could influence how easily educational robotics is incorporated into language instruction, possibly due to differences in how the pedagogical tool could be applied into language teaching contexts.

Teaching with ICT goes beyond simply replacing antiquated tools like the chalkboard with interactive whiteboards in Education 5.0. The use of technology is more of a facilitator to enhance learning and increase effectiveness (Ong & Annamalai, 2023). However, the use of technology in the classroom is a complicated and multifaceted process with a variety of dynamics, including, among others, those relating to the center's digital culture, the proficiency of the teachers and students, the support of the families, and innovation within educational endeavors (Fernández-Sánchez et al., 2022). Since foreign language teachers' knowledge of robotic teaching technology is moderate, more efforts by schools and teachers are required to improve robotics usage.

CONCLUSION

In conclusion, our study aimed to assess foreign language teachers' TPACK, as well as their perceived usefulness of educational robotics, to predict their acceptance of robot-embedded learning. The findings reveal that service length and target language significantly influence teachers' acceptance of educational robotics. Regarding this finding, teacher training should emphasize the development of teachers' BCs and facilitate RU, particularly for more experienced teachers, to foster greater acceptance of ER in language education. Additionally, the results highlight the need to consider subject-specific approaches when implementing educational robotics, as teachers of different languages may require tailored tools and training. By highlighting these factors, our research contributes to the broader field of educational technology adoption.

The results indicate that ER may be more effectively integrated into educational contexts. In practice, these findings underscore the importance of professional development programs that address the unique challenges faced by foreign language teachers when integrating robotics into their classrooms. By providing teachers with the necessary tools and support, educational institutions can enhance the successful adoption of robotics, thereby improving teaching effectiveness and student outcomes in foreign language education.

Future studies should build on these findings to explore additional variables that affect this technology implementation in education, such as school culture or institutional support, that may further influence the acceptance and effectiveness of educational robotics. Additionally, exploring how different languages interact with technological tools in educational settings could yield deeper insights into the personalization of robotics for language learning.

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Ethics declaration: The authors confirm that the research adheres to the Declaration of Helsinki and informed consent was obtained from all participants instead of ethics committee approval. Written informed consent was obtained from all participants and registered as an item of the online survey. As the participants were all adults, the written informed consent assured participants that their participation was anonymous, and that the information provided would be used exclusively for this research and its publication as part of the researcher's thesis. Participants were informed that they would neither benefit nor be disadvantaged by participating in this survey. The written informed consent was attached at the beginning of the ERPA scale. Only those who selected the "agree and continue" button was able to proceed with the survey. Participants who disagreed with the written informed consent could abandon the survey at any time, even after starting the questionnaire. Data was archived solely by the corresponding author.

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