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La placa makey-makey en las aulas universitarias: estudio de la percepción de esta herramienta mediante el modelo de la aceptación de la tecnología

The makey-makey board in university classrooms: a study of the perception of this tool using the technology acceptance model

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RESUMEN

La placa Makey-Makey ha ganado popularidad en el ámbito educativo para estimular la creatividad, la motivación y el pensamiento crítico entre los estudiantes. Por estos motivos, se plantó evaluar la percepción de los estudiantes de magisterio, los futuros docentes, sobre esta herramienta mediante el Modelo de la Aceptación Tecnológica (Modelo TAM) con la finalidad de conocer la utilidad e integración, facilidad y autoeficacia de la placa Makey-Makey. La investigación abarcó dos cursos académicos, involucrado un total de 360 estudiantes matriculados en la asignatura de Tecnologías de la Información y Comunicación Aplicadas a la Educación del Grado de Educación Primaria. La recolección de los datos se realizó mediante un cuestionario online validado a través del análisis factorial exploratorio y confirmatorio sobre el modelo TAM, utilizando una escala Likert. Los resultados evidenciaron una notable aceptación de esta herramienta por parte de los estudiantes, obteniendo una media general de 4,1 puntos sobre 5 y con un nivel de fiabilidad de 0.910. Estos hallazgos respaldan la eficacia y la relevancia de esta herramienta, destacando su potencialidad para enriquecer el proceso de formación. En conclusión, la positiva percepción de los estudiantes sugiere la integración de esta herramienta para ayudar a desarrollar nuevas competencias claves en la formación de los futuros docentes.

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PALABRAS CLAVE

Tecnología educativa; makey-makey; TIC; formación docente; motivación; TAM.

ABSTRACT

The Makey-Makey board has gained popularity in the educational field to stimulate creativity, motivation, and critical thinking among students. For these reasons, it was planned to evaluate the perception of student teachers, future teachers, about this tool through the Technological Acceptance Model (TAM Model) to know the usefulness and integration, ease, and self-efficacy of the Makey-Makey board. The research covered two academic years, involving a total of 360 students enrolled in the subject of Information and Communication Technologies Applied to Education of the Primary Education Degree. Data collection was conducted using an online questionnaire validated through exploratory and confirmatory factor analysis on the TAM model, using a Likert scale. The results demonstrated a remarkable acceptance of this tool by the students, obtaining an overall mean of 4.1 points out of 5 and a reliability level of 0.910. These findings support the effectiveness and relevance of this tool, highlighting its potential to enrich the training process. In conclusion, the positive perception of students suggests the integration of this tool to help develop new key competencies in the training of future teachers.

KEYWORDS

Educational technology; makey-makey; ICT; teacher training; motivation; TAM.

1. INTRODUCTION

The use of technologies has experienced a remarkable growth thanks to the presence of Information and Communication Technologies (ICT) both in daily life and in the educational field, responding to the needs of an increasingly technological society (Villalustre-Martínez, 2024). Specifically, the incorporation of the Internet and the use of technological resources have played a crucial role in the way knowledge has begun to be transmitted. Several authors have explored and analyzed this phenomenon as a result of various constructive approaches, highlighting the importance of these digital resources as pedagogical tools for the construction of knowledge (Pérez de Maza, 2023; Jaramillo-Domínguez and Tena-Pucha 2022; Argüello Rodríguez, 2022; Romero-Tena et al., 2022), so the educational field must be prepared to respond to the needs of an increasingly technological society.

According to the contributions of Yücedağ and Turan (2022), technology is advancing at a rapid pace in all aspects of our daily lives. Therefore, it is imperative to monitor all technological tools, such as smartphones, tablets, computers, the Internet, and digital video games; among other elements, with the purpose of taking advantage of these tools directly to form more orientated and successful learning environments. Furthermore, they argued that the use of the Makey-Makey board could be an excellent tool to increase motivation for learning among early learners, since it helps promote greater interaction with content and technology and offers diverse opportunities for learning (Aydogan & Aydogan, 2020; Onal & Kirmizigul, 2022).

The Makey-Makey board not only focusses on exploring student engagement, but also helps provide other meaningful opportunities in learning a content through firsthand experimentation. Specifically, this tool linked to the Scratch coding program helps to facilitate the learning objective itself; therefore, a knowledge-acquiring environment will develop while students play and learn at the same time (Aydogan & Aydogan, 2020; Tanik Onal and Saylan Kirmizigul, 2022).

The ability to manage Scratch and the Makey-Makey board helps design utility projects that encourage and stimulate critical thinking, creativity, and decision making. Therefore, with its application, it will be possible to develop greater interactions immediately, effective learning, and self-correction of the content that has been acquired (Castro Araya et al., 2020). Studies,

such as those developed by Lozano et al. (2016), showed that the use of the Makey-Makey plate fosters higher-order thinking skills in students.

In other words, the use of educational robotics presents broad perspectives in learning by revealing the potential of these tools in the training processes of students. In addition, it contributes to the psychosocial dimensions of people, motivational and communicative relationships between the student and the teacher, the student with the content, with the collaboration of other classmates, participation, and the resolution and assessment of the task together with the teacher. Therefore, educational robotics not only helps at an early age, but covers all areas; therefore, it helps to redirect learning with greater interaction (Marín-Marín et al., 2020; Sierra-Marín, 2022).

These advances have occurred due to the interest that children and adolescents have begun to develop in acquiring skills with programming, especially orientated to the development of educational games and memory processes. These interests show a predisposition towards learning programming and a good inclination towards learning programming languages for the creation of games; students are beginning to become aware of the importance of technology in contemporary society and the future (Hijón-Neira et al., 2020).

For all these reasons, and in response to the growing integration of technologies in an innovative way in educational environments, the need to evaluate the perception of university students in relation to the use of the Makey-Makey board through the Technological Acceptance Model (TAM Model) was raised to deepen the understanding of the degree of usefulness and integration. ease and self-efficacy of such a tool. By focusing on the TAM, we seek to identify the attitudes that future teachers have about the adoption of the Makey-Makey plate applied to education.

2. METHODOLOGY

2.1. Design and participants

An ex post facto design with intentional sampling was used. The sample size of the research was N = 360 participants, these being students of the Faculty of Education Sciences of the University of Seville, belonging to the degree in Primary Education, and enrolled in the subject of "Information and Communication Technologies Applied to Education" during the academic years 2022-24.

Of these, 287 (79.7%) are women, while the remaining 73 (20.3%) are men, whose age ranged from 18 to 45 years, with an average of 19.34 years, with a standard deviation of 2.418.

Breaking down the data by academic year, it is evident that the total sample, N = 180 students, belongs to the academic year 22-23. Of this group, 35 (19.4%) are men and 145 (80.6) are women. Similarly, there was also a sample of N= 180 students from the 23-24 academic year, whose gender organization is 38 men (21.1%) men and 142 (78.9) women. The average ages for these two academic years were 19.29 and with a standard deviation of 1.549; and, with a mean of 19.38 and a standard deviation of 3.044, respectively.

2.2. Data collection tool

To evaluate the perception of university students in relation to the use of the Makey-Makey board, we adapted Davis (1989) Model of Technological Acceptance.

The instrument was designed based on the contributions of Ganjikhah et al. (2017), Urquidi-Martín et al. (2019), Ursavas (2022), Alzahrani (2023) and Rodríguez-Sabiote et al. (2023) reinforcing the ideas of Cabero-Almenara and Pérez Diez de los Ríos (2018). Likewise, its validation was conducted by means of a factorial and confirmatory analysis, whose process allowed to evaluate the internal structure and confirm the validity of the dimensions that were proposed. This combination strengthened the robustness of the instrument, supporting the

quality of data collection.

The information collection instrument administered in our research is a 5-response Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). This instrument encompassed four key dimensions, each composed of a total of 31 items. The dimensions were:

- Perceived learning (PL): composed of 13 items. This focused on the relationship with which the user learns with the use of technology. This dimension is used to study whether learning is easy and therefore should be adopted.
- Perceived Utility (PU): composed of four items. This dimension focused on the perceptions of students about the usefulness of technology to improve the tasks requested.
- Informatic self-efficacy (CSE): it was formulated using three elements. The project focused on the perceived confidence and skills of students in relation to the use of technology.
- Attitude towards the use of technology (TA): It was composed of 4 elements. This reflected the students' overall assessment and affective disposition towards the technology that was used.
- Behavioral Intent to Use (BIU): This is composed of four items. It focusses on the willingness of users to use technology in the future. Simply put, it is the adoption and employment of technology.
- Perceived Ease of Use (PEU): formulated by three items and focused on students' perception of the ease of technological tools, their simplicity, and clarity in their use.
- In addition to these dimensions, other sociodemographic variables important to our study were included. *2.3.-Procedur.*

First, a justification and theoretical explanation of the use of the Makey-Makey board was presented to the students, indicating all the advantages and possibilities offered by this tool. Then they were given a brief introduction to the basics of electrical circuits and electricity in general to better understand the functionality of the board. Subsequently, it was detailed how the board was connected and used in a general way, as well as the functions it performed, as well as the connection of keys and conductive objects, to which different examples were subjected. After explaining the plaque, two sessions of one hour each were provided for the students to experience the educational possibilities presented by these tools and were encouraged to be creative and weigh how it could be used in different contexts and educational projects as future teachers. Finally, they were asked to create an activity with the use of this tool applied to the stage of primary education and an evaluative questionnaire was provided for data collection.

The assessment instrument was provided as a questionnaire using the Microsoft Forms platform. This questionnaire was administered to students after their participation in the application of the Makey-Makey plate, in the university context, and specifically within the framework of the subject. Data were stored and processed in the SPSS statistical program in version 29.0. Then a comprehensive analysis was conducted across various functions that were integrated into SPSS. This analysis has made it possible to identify patterns, trends, and significant relationships of the results obtained from the questionnaire applied.

3. ANALYSIS AND RESULTS

The analysis of the results that have been collected during these two years has been used through various approaches. First, the reliability of the scale was applied and followed by an exploratory factor analysis (EFA) to study the structure that was presented to the students in relation to the 6 starting dimensions. Subsequently, confirmatory factor analysis (CFA) was applied to confirm the structure resulting from the exploratory factor analysis. Finally, a descriptive analysis of nature was conducted to study the adoption of the Makey-Makey plate.

3.1. Reliability of scale

The reliability scale (see Table 1) has shown that dimension 1 (PL) has a high reliability coefficient, indicating a high internal consistency between the elements of this dimension. In dimension 2 (PU) it also has a high index, although not as strong as PU. In dimension 3 (CSE), it also shows a high index; therefore, there is also an internal consistency, as in dimension 4 (AT). However, dimensions 5 (BIU) and 6 (PEU) are the lowest reliability indices; this could be due to less internal consistency in these dimensions studied. However, the Cronbach alpha coefficient of the total TAM computation is extremely high, 0.949, suggesting that there is strong internal consistency overall. In other words, the combination of samples reflects an internal consistency between all dimensions of the TAM, supporting the reliability and validity of the measurement.

Table 1. Cronbach's alba values and their subscales.

	Cronbach Alpha	N of Elements
Dimension 1 (PL)	,929	13
Dimension 2 (PU)	,822	4
Dimension 3 (CSE)	,790	3
Dimension 4 (AT)	,808	3
Dimension 5 (BIU)	,716	4
Dimension 6 (PEU)	712	3
Total TAM count	,949	31

3.2. Exploratory Factor Analysis

The Exploratory Factor Analysis (EFA) that has been conducted has been conducted through the method of extraction of principal components with Varimax rotation and has emerged in 10 iterations. First, the overall Kaiser-Meyer-Olkin (KMO) sample was calculated, obtaining a high adequacy coefficient, 0.923. This ensures that there are correlations between the variables that are important. Regarding the doctors of the Bartlett sphericity test, 3141,076 (Chi-square) have been obtained; 465 (gl) and <0.01 (p). This means that the presented matrix is not identified with an identity matrix; therefore, there are correlations between the variables that go beyond the diagonal of the displayed matrix.

Table 2 presents the main results of the exploratory factor analysis:

Table 2. Rotated component matrix.

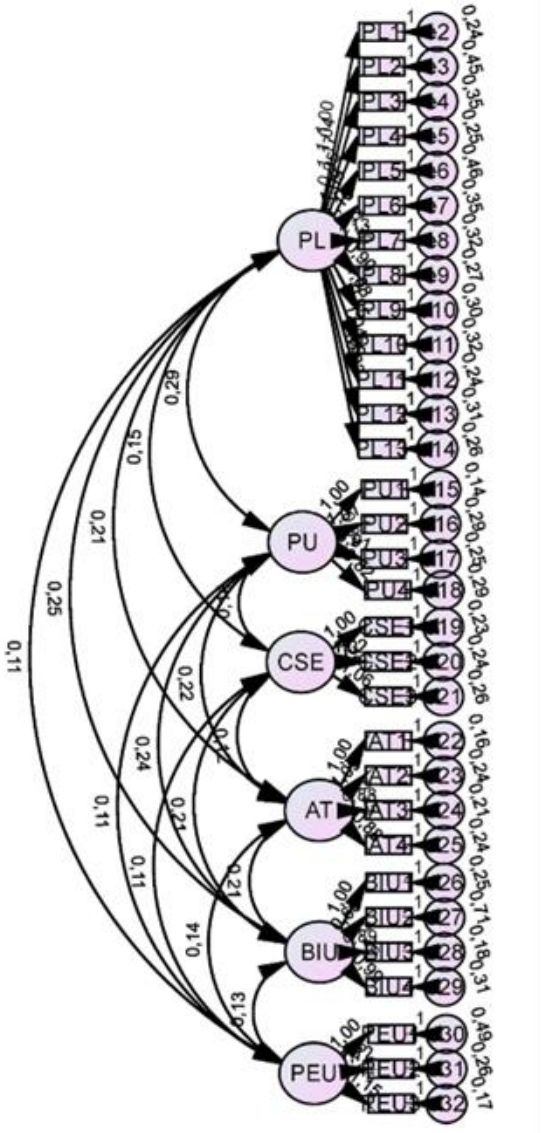
	Component					
	1	2	3	4	5	6
PU1		,729				
PU2		,697				
PU3		,721				
PU4		,452				
PEU1						,575
PEU2						,792
PEU3						,733
AT1				,664		
AT2				,658		
AT3				,588		
AT4				,560		
PL1	,529					
PL2	,546					
PL3	,701					
PL4	,527					
PL5	,740					
PL6	,590					
PL7	,544					
PL8	,649					
PL9	,681					
PL10	,641					
PL11	,615					
PL12	,534					
CPL13	,447					
CSE1			,804			
CSE2			,740			
CSE3			,711			
BIU1					,527	
BIU2					,464	
BIU3					,459	
BIU4					,655	
Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization.[to]						
to. The rotation has converged in 10 iterations.						

Note. Only r>0.400 factor loads r> 0.400 are shown.

3.3. Confirmatory Factor Analysis

To verify and confirm the factor structure using the EFA, the Confirmatory Factor Analysis (CFA) was implemented using the AMOS v.29 program. First, the factorial structure of the scale of the proposed technological acceptance model is presented (Figure 1).

Figure 1. Path diagram of the structure of the TAM model EFA.



Note. Source of own elaboration through the AMOS v.29 program.

As can be seen in the path diagram that represents the structure of the factor analysis of the TAM Model, it confirms the structure. In this model, several standardized factor loads have been obtained, ranging from a value of 0.83 to 1.17 in PL; from 0.82 to 1.01 in PU; from 1 to 1.06 in CSE; from 0.88 to 1.09 in AT; from 0.66 to 1 in BIU; and finally, from 1 to 1.72 in PEU. In general, all items have a strong factor load.

In addition, and based on the recommendations of various authors, it is advisable to contrast several indices of the model to ensure the adjustment; therefore, it is recommended to review

two parsimony adjustment indices: normalized chi-squared (CMIN/DF) and square root error (RMSEA); and, three incremental adjustments: normative adjustment (NFI); incremental adjustment index (IFI) and comparative adjustment index (CFI) (Fernández-García et al., 2008). Therefore, it has been observed that the model has obtained the following measures of goodness. CMIN/DF = 1.719; NFI = 0.788; IFI = 0.899; IFC = 0.897; RMSEA = 0.063.

Apparently, the model fit statistics show an adequacy with the results obtained and approximately; since, according to several authors, the CMIN/DF must be below 5,000 for a good fit of the model; the RMSEA should be less than 0.05 for an adjusted model and between 0.05 and 0.08 for an appropriate model; while the CFI; the NFI and IFI are recommended to be above 0.90 for acceptance of the proposed model (Pérez-Gil et al., 2000; Fernández-García et al., 2008; Fernández et al., 2017). For these reasons, the covariance errors between the proposed items were reviewed to increase the values of the NFI, IFI and CFI and place them above 0.9.

After the elimination of the following items: PL1, PL2, PL3, PL6 and PU1, the following values were obtained: CMIN/DF = 1.637; NFI = 0.816; IFI = 0.919; IFC = 0.918; RMSEA = 0.06. The values obtained indicate that the adjusted model is adequate compared to the other standard reference values. However, although the NFI is still low, the model is considered valid based on the sample of participants used.

Therefore, and to verify the validity of this construct, the reliability scale was applied again, obtaining a value of 0.974 with the 26 items. This suggests that this model is more correct than the one initially proposed, since it has significantly increased the reliability index by reducing 5 items.

3.4. Descriptive analysis

To analyze the acceptance of the Makey-Makey plate against the dimensions integrated in the TAM model, a descriptive analysis of the items resulting from the confirmed model is presented, structured in six dimensions with a total of 26 items (means, standard deviations, and coefficients of asymmetry and kurtosis) (see Table 3).

Table 3. Descriptive analysis of the items studied.

	Descriptive Statistics									
	Academic year 2022 - 2023					Academic year 2023 - 2024				
	Stocking		Desv. standard	Kurtosis	Asymmetry	Stocking		Desv. standard	Kurtosis	Asymmetry
	Statistical	Standard Error	Statistical	Statistical	Statistical	Statistical	Standard Error	Statistical	Statistical	Statistical
PL4	3,9000	,08000	1,07329	-,349	-,649	4,2833	,05417	,72678	,192	-,757
PL5	3,6167	,08923	1,19718	-,706	-,645	4,0444	,06536	,87691	1,428	-1,042
PL7	3,8000	,07736	1,03783	,094	-,500	4,0667	,06283	,84298	,832	-,806
PL8	3,9556	,06906	,92647	-,666	-,465	4,3500	,05371	,72061	,472	-,911
PL9	3,7944	,07626	1,02318	-,676	-,400	4,1611	,06060	,81305	,991	-,935
PL10	3,9389	,07846	1,05260	,274	-,836	4,2611	,05479	,73510	-,672	-,540
PL11	3,9000	,07437	,99776	-,234	-,514	4,1556	,05617	,75356	-,348	-,503
PL12	3,8278	,07989	1,07189	-,060	-,504	4,1056	,06128	,82216	-,575	-,503
PL13	3,9056	,07787	1,04479	,071	-,849	4,2278	,05156	,69178	-,006	-,540
PU2	3,8500	,07897	1,05954	-,221	-,722	4,0500	,05963	,79997	-,685	-,355
PU3	3,8389	,07523	1,00925	,571	-,660	4,3000	,05453	,73157	-,193	-,708
PU4	3,9444	,07421	,99565	-,074	-,712	4,3389	,05411	,72593	1,715	-1,062

CSE1	4,0611	,07313	,98119	,977	-,805	4,1556	,05391	,72329	-1,056	-,245
CSE 2	4,0889	,07569	1,01546	,793	-1,054	4,2611	,05479	,73510	-,672	-,540
CSE 3	3,9778	,07001	,93925	,038	-,651	4,0500	,05696	,76425	-,383	-,389
AT1	4,0500	,07402	,99313	,147	-1,035	4,5722	,04794	,64323	2,082	-1,483
AT2	4,0444	,07832	1,05079	-,670	-1,083	4,5000	,05487	,73614	3,033	-1,614
AT3	3,9611	,08164	1,09526	-,506	-,877	4,5000	,04760	,63861	,605	-1,041
AT4	3,9389	,07356	,98686	-,123	-,723	4,3889	,04945	,66340	,000	-,745
BIU1	3,9167	,07593	1,01868	-,085	-,569	4,1278	,05517	,74015	-,275	-,459
BIU2	4,0944	,06900	,92572	-,608	-,617	4,2444	,06851	,91921	2,518	-1,466
BIU3	3,8389	,07806	1,04728	,086	-,676	4,3778	,04802	,64432	,064	-,674
BIU4	3,7833	,08568	1,14957	-,099	-,727	4,1500	,05761	,77297	-,774	-,413
PEU1	3,5778	,08701	1,16732	-,349	-,488	4,1778	,06111	,81983	-,184	-,709
PEU 2	3,7389	,08352	1,12047	-,706	-,770	4,3500	,06614	,88737	2,175	-1,526
PEU 3	3,8778	,08473	1,13677	,094	-,819	4,4722	,04755	,63800	,440	-,939

As can be seen, in the 2022-2023 academic year, values between 3.57 and 4.09 have been achieved (corresponding to the moderately agree and strongly agree categories), suggesting that these values are among an average acceptance value. The average acceptance rate for the Makey-Makey plate is 3.89. In relation to the standard error of the mean, it is observed that they are exceptionally low, indicating a high reliability in the representative means of the selected sample. Regarding the standard deviation, used as a measure of dispersion, it is remarkably close to 1, presenting values lower than or higher than this value; therefore, there is variability in the dispersion of the data obtained from this course. In relation to kurtosis, it reveals that the values are between -0.706 and 0.977, suggesting that the distribution of the data changes in each case. This is useful to understand the specific differences in each context and/or moments. On the other hand, the asymmetry presented values between -1.083 and -0.4, highlighting more pronounced trends towards the left side of the distribution.

After this academic year, it is essential to establish a relationship with the data collected in the current academic year 2023 - 2024. In relation to the mean, values ranging from 4.04 to 4.57 were recorded, suggesting a general increase in the acceptance of the Makey-Makey plate; The average was 4.26. Furthermore, it was observed that the standard error of the mean is slightly lower in this course than in the previous, suggesting a higher reliability in the means obtained. Regarding the standard deviation, it was observed that it fluctuated between 0.638 and 0.919, lower values than the previous, indicating greater homogeneity among the responses that selected the sample. In relation to kurtosis, disparate values were recorded, ranging from -1.056 to 3.033. This indicates significant changes in the distribution of data and presents a more pronounced distribution; Therefore, it is not a distribution of data excessively to a normal distribution. Finally, in relation to asymmetry, a greater diversity is observed, covering ranges between -1.614 and -0.245, suggesting a tendency towards the left side as the previous one.

Subsequently, an analysis of variance (ANOVA) was performed on these data to observe if there

are statistically significant differences between the subjects of both academic years. The results can be seen in Tables 4, 5 and 6.

Table 4. Data from the analysis of variance (Anova) academic year 22-23.

		Sum of squares	Gl	Quadratic mean	F	Gis
Inter-subjects		3582,350	179	20,013		
Intra-subjects	**Between Elements**	75,648	25	3,026	9,012	<,001
	Residue	1502,583	4475	,336		
	Total	1578,231	4500	,351		
Total		5160,581	4679	1,103		
Global Mean = 3.8932						

Table 5. Data from the analysis of variance (Anova) course 23-24.

		Sum of squares	Gl	Quadratic mean	F	Gis
Inter subjects		1036,064	179	5,788		
Intra-subjects	**Between Elements**	103,967	25	4,159	11,440	<,001
	Residue	1626,764	4475	,364		
	Total	1730,731	4500	,385		
Total		2766,795	4679	,591		
Global Mean = 4.2566						

Table 6. Analysis of variance (Anova) data across the board.

		Sum of squares	Gl	Quadratic mean	F	Gis
Inter-subjects		4927,538	359	13,726		
Intra-subjects	**Between Elements**	124,680	25	4,987	14,057	<,001
	Residue	3184,281	8975	,355		
	Total	3308,962	9000	,368		
Total		8236,500	9359	,880		
Global Mean = 4.0749						

The intersubject test showed that there is significant variability among students. Likewise, in the intrasubject test, significant differences were also identified, suggesting the presence of factors that influence the acceptance of the technology. However, the non-additivity test did not reveal significance, indicating that the variability is not attributed to a lack of data. As for the overall average acceptance of the Makey-Makey plate by students, it stood at 3.89 out of 5 points in the 22-23 academic year and 4.26 in the 23-24 academic year, which denotes a high acceptance

of this technology. In fact, when analyzed in general, the average is 4.08, which suggests a good degree of acceptance of this tool. In relation to overall significance, it is observed that it is exceptionally low, being less than 0.001, which supports the idea of the presence of significant differences in the acceptance of the Makey-Makey plate.

These findings provide a deeper understanding of the variables in the perception and adoption of technology, which underlines the importance of factors when designing strategies to promote the acceptance of a resource among all students, although, it is worth mentioning that it has had a good assessment by users in all the dimensions studied; the items that compose it have been valued with a good evaluation, and being increased in the 23-24 academic year.

4. DISCUSSION AND CONCLUSION

Education should ensure that students have the opportunity to design and build their ideas with and through technology, rather than simply being users or consumers (Barroso-Osuna, et al., 2018; Quintana-Ordorika et al., (2023), likewise, become key strategies to improve the quality of higher education teaching (Salinas et al., 2022); Educational technologies contribute to people's cognitive and psychological development, giving importance to confidence to achieve academic success (Khan et al., 2023).

Technological tools such as the Makey-Makey board are considered innovative educational tools, capturing the attention of both teachers and students (Roger et al, 2002), favoring the stimulation of creativity (Morais et al., 2019), student motivation, cooperative learning, peer learning and meaningful learning (Lozano et al., 2019) , as well as fostering critical thinking (Soto-Solier et al., 2023), helping them gain confidence about themselves and the work they are doing (Özer & Demirbatir, 2023; Lin et al., 2023). In fact, these aspects are considered to be of great importance for learning; because, with this, it not only focuses on the acquisition of knowledge, but also on developing certain fundamental skills for daily tasks (Fokides & Papoutsi, 2019; Hijón-Neira et al., 2020; Pérez-Marín & Hijón-Neira, 2022), favouring the development of key skills such as the competence to learn how to learn (Fokides & Papoutsi, 2019).

Based on the objectives set out in our research, the study has revealed a high acceptance of this tool by students, obtaining an overall average of 4.08 out of 5 on the six dimensions, with a reliability level of 97.4%. Therefore, it is stated that the Makey-Makey plate is considered a tool of great efficacy and relevance in education, corroborating the results with other studies of a similar nature (Castro et al., 2020; Vicente-Bújez, et al., 2019). This high acceptance can be attributed to various aspects such as the ability that can be obtained with the use of this resource to encourage student participation, the creation of projects, and the various applications that it can have in education and related to various subjects of the official curriculum; since, with it, not only the active participation of the students is sought, but also the collaboration and cooperation between the class group.

In other words, this study has shown the widespread acceptance, backed by high reliability, of this tool with a significant potential to contribute to the training of future teachers; therefore, it can also improve the learning of students at an early age and adolescent. Recent studies demonstrate the benefits of its use in non-university education (Hijon-Neira et al., 2020), as well as the advantages of its use in students with special educational needs (Calleja et al., 2025; Li & Kang, 2021; Mäkelä & Virpi, 2018). Their integration into educational contexts, especially in the initial training of teachers, contributes to the development of new key competencies, such as creativity, motivation, and critical thinking. In addition, it contributes to the construction of various skills in the learning of any subject.

For these reasons, it could be said that the introduction of this technological tool in the classroom is considered a positive step towards a more interactive, participatory learning with a totally transformed pedagogical approach adapted to the current demands of society: the use of technology in contemporary life.

Finally, it should be noted that the positive perception of students about the Makey-Makey board

not only validates the usefulness, ease of use, and computer self-efficacy, but also qualifies the high potential to transform the teaching-learning processes. This offers a solid basis to further implement this type of technology in educational environments, thus contributing to the training of future generations, who seek learning more adapted to the education of the 21st century.

Authors' contribution

Gutierrez-Castillo, J.J.: conceptualization, formal analysis, funding acquisition, research, methodology, writing – original draft, writing – revision and editing

León-Garrido, A.: conceptualization, data curation, research, methodology, validation, writing – original draft, writing – revision and editing

Barroso-Osuna, J.: conceptualization, research, methodology, writing-revision, and editing

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REFERENCES

Alzahrani, A. (2023). An analysis of the Technology Acceptance Model TAM in understanding Faculty's behavioral intention to use Internet of Things IOT. *IJERI: International Journal of Educational Research and Innovation*, (19), 153–169. https://doi.org/10.46661/ijeri.7461

Argüello Rodríguez, J. D. (2022). Educational technology and higher education. *Ciencia Latina Multidisciplinary Scientific Journal*, *6*(6), 10566–10579. https://doi.org/10.37811/cl_rcm.v6i6.4149

Aydogan, A., & Aydogan, SK. (2020). The effectiveness of teaching english with makey makey in children with autism spectrum disorder. *IJAEDU- International E-Journal of Advances in Education*, *6*(16), 965–974. https://doi.org/10.18768/ijaedu.616018

Barroso-Osuna, J., Cabero-Almenara, J., & Gutiérrez-Castillo, J.J. (2018). The production of learning objects in augmented reality by university students. Degree of acceptance of this technology and motivation for its use. *Mexican Journal of Educational Research*, *23*(79), 1261-1283.

Cabero-Almenara, J., & Pérez Díez de los Ríos, J. L. (2018). Validation of the TAM model for the adoption of Augmented Reality using structural equations. *Studies in Education*, *34*, 129–153. https://doi.org/10.15581/004.34.129-153

Calleja M., Luque M. L., Rodríguez J. M. & Liranzo A. (2015). Increased language proficiency in two subjects with Cerebral Palsy using the Makey-Makey device. A case study. *Journal of Research in Speech Therapy, 5*(2), 112-134. https://doi.org/10.5209/rlog.58622

Castro Araya, H., Arguedas Quesada, C., & Cortés, K. R. (2020). Pedagogical accompaniment of the Learning Technologies Program [Protea]: A constructivist experience that takes advantage of Makey Makey and Scratch to enrich a course in Musical Expression. *Education Magazine*. https://doi.org/10.15517/revedu.v44i2.39179

Davis, F.D. (1989). Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information Technology. *MIS Quarterly*, 13, 319-340. https://doi.org/10.2307/249008

Fernández, M., Benítez, J. L., Pichardo, M. C., Fernández, E., Justicia, F., García, T., García-Berbén, A., Justicia, A., & Alba, G. (2017). Confirmatory factor analysis of the PKBS-2 subscales for the assessment of social skills and behavioral problems in early childhood education. *Electronic*

Journal of Research in Education Psychology, *8*(22), 1229-1252 https://doi.org/10.25115/ejrep.v8i22.1415

Fernández-García, E., Sánchez-Bañuelos, F., & Salinero-Martín, J. (2008). Validation and adaptation of the PACES scale of enjoyment with the practice of physical activity for Spanish adolescents. *Psychothema*, *20*(4), 890–895.

Fokides, E., & Papoutsi, A. (2019). Using Makey-Makey for teaching electricity to primary school students. A pilot study. *Education and Information Technologies*, *25*(2), 1193–1215. https://doi.org/10.1007/s10639-019-10013-5

Ganjikhah, A., Rabiee, A., Moghaddam, D. K., & Vahdat, D. (2017). Comparative analysis of bank's ATM and POS technologies by customers. *Independent Journal of Management & Production*, *8*(3), 831. https://doi.org/10.14807/ijmp.v8i3.528

Hijon-Neira, R., Pérez-Marín, D., Pizarro, C., & Connolly, C. (2020). The effects of a visual execution environment and makey makey on primary school children learning introductory programming concepts. *IEEE Access*, *8*, 217800–217815. https://doi.org/10.1109/access.2020.3041686

Jaramillo Domínguez, D. C., & Tene Pucha, J. E. (2022). Exploring the Use of Educational Technology in Basic Education. *PODIUM*, *41*, 91–104. https://doi.org/10.31095/podium.2022.41.6

Khan, A., Ze, I., Zhang, Y., & Tahir. (2023). Impact of emerging technologies on cognitive development. *IJERI: International Journal of Educational Research and Innovation*, *20*, 1–15. https://doi.org/10.46661/ijeri.8362

Li, X. & Kang, X. (2021). Thinking and Chibitronics and Makey Makey to Develop a Social Story Teaching Aid System to Improve Social Reciprocity and Emotional Expression Skills for Autistic Children. *ACM International Conference Proceeding Series.* https://doi.org/10.1145/3450148.3450150

Lin, Y.-H., Rong, J.-Y., & Lin, H.-C. K. (2023). The effect of makey makey combined with tangible learning on marine conservation outcomes with attitude and learning satisfaction of rural elementary school students. In *Lecture Notes in Computer Science* (pp. 567–576). Springer Nature Switzerland. http://dx.doi.org/10.1007/978-3-031-40113-8_56

Lozano, P., Guerrero, B.A., & Gordillo, W.D. (2026). Scratch and Makey Makey: Tools to foster higher-order thinking skills. *Ing. Redes*, 1, 16-23.

Mäkelä, S. & Virpi, V. (2018). Designing for appropriation: A DIY kit as an educator's tool in special education schools. *International Journal of Human-Computer Studies*, 118, 14-23. https://doi.org/10.1016/j.ijhcs.2018.05.004

Marín-Marín, J.-A., Costa, R. S., Moreno-Guerrero, A.J., & López-Belmonte, J. (2020). Makey makey as an interactive robotic tool for high school students' learning in multicultural contexts. *Education Sciences*, *10*(9), 239. https://doi.org/10.3390/educsci10090239

Morais, I., Bachrach, M.S. (20219). Analysis of the impact of computer workshops on secondary school teachers. In Proceedings of the 2019 IEEE Integrated STEM Education Conference (ISEC), Princeton, New Jersey, USA, March 16, 2019; pp. 57–61. https://doi.org/10.1109/ISECon.2019.8882115

Özer, Z., & Demirbatır, R. E. (2023). STEAM based music activity example for gifted students. *LUMAT: International Journal on Math, Science and Technology Education*, *11*(4). https://doi.org/10.31129/lumat.11.4.1993

Pérez de Maza, T. (2023). The role of educational technology in distance education. *Journal of Multi-Essays*, *9*(17), 19–30. https://doi.org/10.5377/multiensayos.v9i17.15738

Pérez-Gil, J. A., Chacón-Moscoso, S., & Moreno-Rodríguez, R. (2000). Construct validity: the use of exploratory-confirmatory factor analysis to obtain evidence of validity. *Psychothema*, *12*(2), 442–446.

Pérez-Marín, D., Hijón-Neira, R., Romero, A., & Cruz, S. (2022). Is the use of Makey Makey Helpful to

Teach Programming Concepts to Primary Education Students? In *Research Anthology on Computational Thinking, Programming, and Robotics in the Classroom* (pp. 631–647). IGI Global. http://dx.doi.org/10.4018/978-1-6684-2411-7.ch029

Quintana-Ordorika, A., Camino-Esturo, E., & Portillo-Berasaluce, J. (2024). Integrating the Maker pedagogical approach in teacher training: the acceptance level and motivational attitudes. *Educ inf technol 29*, 815–841. https://doi.org/10.1007/s10639-023-12293-4

Rodríguez-Sabiote, C., Valerio-Peña, A. T., & Batista-Almonte, R. (2023). Validation of a scale of the Extended Technology Acceptance Model in the Dominican context. *Pixel-Bit. Journal of Media and Education*, *68*, 217–244. https://doi.org/10.12795/pixelbit.100352

Rogers, Y., Paay, J., Brereton, M., Vaisutis, K. L., Marsden, G., & Vetere, F. (2014). Never too old: Engaging retired people inventing the future with MaKey MaKey, in Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Toronto, Ontario, Canada, pp. 3913–3922. https://doi.org/10.1145/2556288.2557184

Romero-Tena, R., Barragán-Sánchez, R., Martínez-Pérez, S., & Palacios-Rodríguez, A. (2022). Habits, norms and use of technologies in early childhood households from a gender perspective. *Digital Education Review*, *41*, 19–31. https://doi.org/10.1344/der.2022.41.19-31

Salinas-Ibáñez, J., de Benito-Crosetti, B., Moreno-García, J., & Lizana Carrió, A. (2022). New flexible designs and modes of organisation in higher education. *Pixel-Bit. Journal of Media and Education*, 63, 65-91. https://doi.org/10.12795/pixelbit.91739

Serra-Marín, L., & Berbel-Gómez, N. (2021). The impact of the use of technology on student engagement and motivation in the music classroom. *Journal of Music, Technology & Education*, *14*(2), 157–178. https://doi.org/10.1386/jmte_00039_1

Soto-Solier, P. M., Villena-Soto, V., & Molina-Muñoz, D. (2023). Perceptions of future teachers on the inclusion of creative robotics in Primary Education. *Pixel-Bit. Journal of Media and Education*, 67, 284-314. https://doi.org/10.12795/pixelbit.96781

Tanik Onal, N., & Saylan Kirmizigul, A. (2021). A Makey-Makey based STEM activity for children. *Science Activities*, *58*(4), 166–182. https://doi.org/10.1080/00368121.2021.2011086

Urquidi-Martín, A. C., Calabor Prieto, M. S. & Tamarit Aznar, C. (2019). Virtual Learning Environments: An Expanded Model of Technology Acceptance. *Electronic Journal of Educational Research*, *21*(e22), 1-12. https://doi.org/10.24320/redie.2019.21.e22.1866

Ursavaş, Ö. F. (2022). *Conducting technology acceptance research in education: Theory, models, implementation, and analysis*. Springer International Publishing. https://doi.org/10.1007/978-3-031-10846-4

Vicente-Bújez, M. R., Díaz-Mohedo, M. T., López-Belmonte, J., & Pozo-Sánchez, S. (2019). Education and development of body expression and auditory discrimination through robotic tools. *Journal of Sport and Health Research. 11(Suppl 1),* 115-126.

Villalustre-Martínez, L. (2024). Analysis of the level of computational thinking of future teachers: a diagnostic proposal for the design of training actions. *Pixel-Bit. Journal of Media and Education*, 69, 169-194. https://doi.org/10.12795/pixelbit.101205

Yücedağ, L., & Turan, M. (2022). The effect of makey makey use on students' academic achievement and attitudes in primary literacy teaching with technoorganic education model. *Revista de Investigaciones Universidad Del Quindío*, *34*(2). https://doi.org/10.33975/riuq.vol34n2.917