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Artículo original

Is the use of ICTs related to academic performance in technological education? A case study in the rural sector

¿Se relaciona el uso de las TICs con el rendimiento académico en la educación tecnológica? Un estudio de caso en el sector rural

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ABSTRACT

The relationship between ICT proficiency and academic performance (AR) of 148 students of an Ecuadorian Technological Institute, located in a rural sector, was studied. The Cuestionario de Competencias Tecnológicas de los alumnos/as (Llorente Cejudo & Cabero Almenara, 2010), adapted from Aranda Garrido et al. (2019) (α:0.87), made up of 56 items, [(Responses 1: totally incapable) to (5: total mastery of the skill)], was used. Four dimensions were analyzed: Basic knowledge in the management of technological tools - BKTT); Medium knowledge in the management of technological tools - AVKTT; Advanced knowledge in the management of technological tools - ADKTT; and the Use and knowledge of technological laboratories and virtual teaching (UKTLVT). The AR was classified ordinally in 5 levels ranging from Excellent to Deficient. Jamovi 2.5.6 software was employed for descriptive and inferential calculations. Frequencies, percentages, and centralized (mean) and dispersion (standard deviation) measures were explored. Correlation was based on Spearman's test (α: 0.05): H1: Rho between ICT use ↔ AP $p \leqslant 0.05$. Relationships were also explored at the dimension level, and between these and the AR variable. The results of ICT proficiency, their degrees of proficiency and AR reveal a panorama where gaps emerge that need to be filled. The majority of students reflect a medium level of mastery for tasks typical of advanced, medium and low levels of work. The percentages of high mastery varied inversely with the degree of demand, being higher for lower level tasks, but decreasing markedly when the complexity increases. Significant relationships were identified at the intramodel level, but this was not appreciated at the variable level, which is not consistent with those reported in the existing literature.

Keywords: Technological education; Tics-student performance relationship; Academic performance; Educational use of ICTs.

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RESUMEN

Se estudió la relación entre el dominio de las TICs y el rendimiento académico (AP) de 148 estudiantes de un Instituto Tecnológico ecuatoriano, ubicado en un sector rural. Se empleó el Cuestionario de Competencias Tecnológicas de los alumnos/as (Llorente Cejudo & Cabero Almenara, 2010), adaptado de Aranda Garrido et al. (2019) (α:0.87), conformado por 56 ítems, [(Respuestas 1: totalmente incapaz) hasta (5: dominio total de la habilidad)]. Se analizaron 4 dimensiones: Conocimiento básico en el manejo de herramientas tecnológicas - BKTT); Conocimiento medio en el manejo de las herramientas tecnológicas – AVKTT; Conocimiento avanzado en el manejo de las herramientas tecnológicas – ADKTT; y el Uso y conocimientos de los laboratorios tecnológicos y enseñanza virtual (UKTLVT). El AP se clasificó de manera ordinal en 5 niveles que comprenden desde Excelente hasta Deficiente. El software Jamovi 2.5.6 fue empleado para los cálculos descriptivos e inferenciales. Se exploraron las frecuencias, porcentajes y medidas centralizadas (media) y de dispersión (desviación estándar). La correlación se basó en el test de Spearman (α: 0.05): H1: Rho entre uso de las TICs ↔ AP $p \leq 0.05$. Las relaciones también se exploraron a nivel de dimensiones, y entre estas y la variable AP. Los resultados de dominio de las TICs, sus grados de dominio y el AP revela un panorama donde emergen brechas que deben ser subsanadas. La mayoría de los estudiantes refleja un grado de dominio medio para tareas propias de niveles trabajo avanzado, medio y bajo. Los porcentajes de dominio alto variaron inversamente con el grado de exigencia, siendo mayores para las tareas de más bajo nivel, pero disminuyendo notoriamente cuando la complejidad se incrementa. Se identificaron relaciones significativas a nivel intramodelo, pero esto no se apreció a nivel de variables, lo que no es consistente con los reportado en la literatura existente.

Palabras claves: Educación tecnológica; Relación Tics-Desempeño estudiantil; Rendimiento académico; Uso educativo de las TICs.

INTRODUCTION

Information and communication technologies (ICTs) are related to software and hardware devices that allow the transfer of data (Navarrete Enríquez et al., 2024), therefore, using computers and the internet, improving communication between interconnected subjects asynchronously or synchronously; therefore, they are important in the dissemination of information and knowledge in an organized and effective manner (Lai & Bower, 2020; Reyes et al., 2023; Reyes et al., 2024).

Currently, ICT-based applications have covered all fields of life, including education. The pedagogical experiences mediated by ICTs are extensive (Radianti et al., 2020); extensive reports have been found in university education (Karpov, 2017; Tejedor et al., 2018; Sweller, 2020), as well as in urban contexts (Ortiz Mosquera et al., 2023) and rural contexts (Pacheco & Jiménez, 2018). On the other hand, the integration of ICTs in tertiary technical and technological education has been a transformative process that has reconfigured traditional teaching and learning paradigms (Martínez-Abad et al., 2017; Navarrete Enríquez et al., 2024).

In Ecuador, the incorporation of ICTs still entails challenges in terms of their implementation and adoption in technical education environments (Navarrete Enríquez et al., 2024). According to Fernández-Batanero et al. (2021), currently thinking about an education based on ICTs implies the management of Learning Management Systems (LMS), which include platforms such as Blackboard, Moodle, and Canvas, which have become omnipresent in the educational processes of the higher education system, since they facilitate the management of courses, content delivery, access, and interactions between teachers and students (Aldiab et al., 2019).

The use of modeling and simulation software is also considered, which is fundamental in the field of technical education, thus allowing interaction with complex systems and processes in virtual environments, which helps to improve understanding and practical skills (Kapilan et al., 2021). Similarly, the use and management of cloud-based collaborative tools, as well as having project management software available, are of interest to promote collaborative and teamwork, as well as communication skills, which are basic in modern technical professions (Hernández-de-Menéndez et al., 2020).

Augmented and virtual reality (AR/VR) is also currently used to offer immersive learning experiences, especially relevant in the field of medical technology and engineering (Martín-Gutiérrez et al., 2017; Akçayır & Akçayır, 2017)). All this goes hand in hand with mobile learning, based on the usefulness of using smartphones and tablets for educational purposes, which offers flexibility and accessibility for learning (Crompton & Burke, 2018; Alonso Conde, 2021)). All this without leaving aside the trend of use and implementation of the automation of educational processes based on artificial intelligence (Chen, 2019; Castrillón et al., 2020).

It has also been shown that ICTs generate favorable effects on learning (Albó et al., 2019; Fonseca et al., 2021; Miguel-Revilla, 2020; Balladares-Domo et al., 2023; Antonietti et al., 2022; Campuzano et al., 2022; Navarrete Enríquez et al., 2024), and that it is possible to identify differences in terms of gender (Aranda Garrido et al., 2019). In Spain, Díaz-García et al. (2020) reported the relationship between pedagogical competencies and aspects of ethics, the academic use of ICTs in the classroom and non-academic, perceptions of the deep approach and the superficial approach, highlighting the relevance of ICTs and the importance of providing training to students in pedagogical and ethical competencies linked to ICTs. since this would promote the development of deep learning (Díaz-García et al., 2020).

According to Díaz Vera et al. (2021), the mastery and correct use of computer and educational communication tools, such as the Classroom, Meet, GoogleForms platforms, among others, contribute to obtaining better academic performance, agreeing with Jiménez et al. (2020), in that there are technological factors that affect academic performance in universities. In Ecuador, education in rural areas still faces challenges such as lack of access to technological resources of an educational nature and there is a shortage of trained teachers (Pacheco & Jiménez, 2018).

In technical and technological education this seems to still be present. This facilitates the establishment of gaps in terms of students' technological skills. There are questionnaires to explore the Technological Competences of students (Llorente Cejudo & Cabero Almenara, 2010), and they have been adapted (Aranda Garrido et al., 2019). This paper explores the basic, medium and advanced knowledge in the management of technological tools, as well as the use and knowledge of technological laboratories and virtual teaching (UKTLVT), in students of an Ecuadorian technological institute, located in a rural context.

At the same time, the relationship between ICT mastery and the academic performance of these students is studied. The work is part of the institutional diagnoses, which are carried out within the framework of the accreditation processes. It aims to generate metrics on indicators, and that this contributes to improving pedagogical management.

METHODOLOGY

It is quantitative research, with a non-experimental design and a descriptive and correlational scope around the use of ICTs and AR. 148 students from an Ecuadorian Technological Institute, located in a rural sector, whose students took the 2023-II cycle, were consulted. Subjects who were formally enrolled, and who accessed freely and voluntarily, were included. The Questionnaire on Students'

Technological Competences (Llorente Cejudo & Cabero Almenara, 2010), adapted from Aranda Garrido et al. (2019), was used, and is made up of 56 items, with ordinal response options such as Likert [(1: totally incapable) to (5: total mastery of the skill)]. The first dimension (Basic knowledge in the use of technological tools - BKTT), contemplated the first 15 items. The second dimension (items 16 – 32) focuses on Average knowledge in the use of technological tools – AVKTT.

The third dimension explores Advanced knowledge in the use of technological tools (ADKTT: items 33 – 52), while items 53 – 56 correspond to the dimension that measures the Use and knowledge of technological laboratories and virtual teaching (UKTLVT). The reliability calculated with a pilot test was 0.87.

The AP was obtained by observing the grade sheets, where the general average is summarized. The evaluation levels are made up of: Excellent (9.50 – 10.00). Very good (9.00 – 9.49). Good (8.00 – 8.99). Regular (7.00 – 7.99). Deficient (0.00 – 6.99). The Jamovi 2.5.6 software was used for descriptive and inferential calculations.

Frequencies, percentages, and centralized (mean) and dispersion (standard deviation) measures were explored. The correlation was based on Spearman's test (α: 0.05): H1: Rho between ICT use AP $p \leq 0.05$. ↔ Relationships were also explored at the level of dimensions, and between these and the AP variable.

RESULTS

The analysis was segmented by dimensions, the results of which are presented below:

Table 1

Frequencies of the ICT domain: BKTT dimension

BKTT Levels	Frequencies (F)	% of Total	% Accumulated
Low	17	11.5 %	11.5 %
Middle	72	48.6 %	60.1 %
High	59	39.9 %	100.0 %

Table 1 shows that medium (F: 72; 48.6%) and high (F: 59; 39.9%) levels of proficiency predominate. However, there are still 11.5% of students with a low level. Therefore, it is considered that 60.1% of the students do not have the mastery of the necessary competencies in the BKTT dimension. This is striking, because they are the lowest-level competencies.

Table 2

Frequencies of the ICT domain: AVKTT dimension.

AVKTT Levels	Frequencies (F)	% of Total	% Accumulated
Low	33	22.3 %	22.3 %
Middle	80	54.1 %	76.4 %
High	35	23.6 %	100.0 %

Table 2 showed that the domain for the MHHC dimension again revealed a prevalence of medium (F: 80; 54.1%) and high (F: 35; 23.6%) levels of mastery of what this component implies. However, there are still 11.5% of students with a low level. Therefore, it is considered that 76.4% of the subjects consulted do not have a high command of the competencies required in the BKTT dimension. It can be seen that the percentage of the high level decreased compared to the AVKTT dimension.

Table 3

Frequencies of the ICT domain: ADKTT dimension.

ADKTT Levels	Frequencies (F)	% of Total	% Accumulated
Low	61	41.2 %	41.2 %
Middle	75	50.7 %	91.9 %
High	12	8.1 %	100.0 %

Table 3 summarizes the students' mastery of the ADKTT dimension. For this advanced skill component, there is a marked decrease in the expertise corresponding to a high level (F: 12; 8.1%), and the prevalence again of the medium level (F: 75; 50.7%); while the low level exhibits the highest percentage among the three components (F: 61; 41.2%). In terms of percentage aculate, it is revealed that 91.9% adjust to low or medium levels. This is an important gap to fill.

Table 4
Frequencies of ICT use: UKTLVT dimension.

UKTLVT Levels	Frequencies (F)	% of Total	% Accumulated
Low	47	31.8 %	31.8 %
Middle	68	45.9 %	77.7 %
High	33	22.3 %	100.0 %

The table above (Table 4) expresses the values that summarize the student proficiency metrics in terms of the UKTLVT dimension. A prevalence of medium (F: 68; 45.9%) and high (F: 33; 22.3%) levels is distinguished in terms of the domain required for this component. However, 31.8% of subjects are identified with a low level in terms of the use and knowledge of technology laboratories and expertise in virtual education. A cumulative percentage of 77.7% of the subjects have deficiencies in this dimension, which could condition their transit through education mediated by virtual platforms.

Table 5
AR tiered

Levels	Frequencies (F)	% of Total	% Accumulated
Very Good (9.00 – 9.49)	10	6.8 %	6.8 %
Good (8.00 – 8.99)	60	40.5 %	47.3 %
Regular (7.00 – 7.99)	53	35.8 %	83.1 %
Deficiente (0.00 – 6.99)	25	16.9 %	100.0 %

Regarding the AP, it can be seen that the bulk of the students are located in the Good (F: 60; 40.5%) and regular (F: 53; 35.8%) levels. The percentage of poor performance is 16.9%, which is high for the system; while the very good level only groups 6.8%. In cumulative terms, only 47.3% have a performance that is positioned above the 80th percentile of the scale.

Table 6

		BKTT		AVKTT		ADKTT
AVKTT	Rho	0.841	***	—		
	p	<.001		—		
ADKTT	Rho	0.634	***	0.773	***	—
	p	<.001		<.001		—

UKTLVT	Rho	0.569	***	0.589	***	0.609	***
	p	<.001		<.001		<.001	

The examination of correlations by dimensions (Table 6) reveals the existence of direct and significant correlations between the components that make up the ICT domain model.

In this sense, the BKTT ↔ components AVKTT (Rho: 0.841; p < .001), BKTT ↔ ADKTT (Rho: 0.634; p < .001) and BKTT ↔ UKTLVT (Rho: 0.569; p < .001) and the relationships between AVKTT, ADKTT and UKTLVT also exhibit significant values of Rho and p values (Rho: p < .001; rejection of the H0 of absence of correlation), which shows relationships mainly marked by the prevalence of medium levels of ICT proficiency.

Table 7
Correlation Matrix

		USE OF ICTS
AP	Rho	-0.003
	p	0.973

Note: H0 is accepted.

The correlation between AR and the domain of HT linked to ICTs (HT↔AP H_0: no relationship) showed that there was no relationship between the two (e.g. > value 0.05 (H 1 is accepted) (see Table 7). Based on this, the dispersion by levels and the prevalence of medium levels of proficiency do not manifest favorably in performance.

DISCUSSION

The results of ICT mastery, their degrees of mastery and the AP reveal a panorama where gaps emerge that must be corrected. Most students reflect a medium degree of mastery for tasks typical of advanced, medium and low work levels. The percentages of high proficiency varied inversely with the degree of demand, being higher for the lowest-level tasks, but decreasing markedly when complexity increases. This data suggests that, although there are deficiencies in the technological training of most students, there is a group that has managed to develop skills that allow them to perform better academically, but that are an exception that is summarized in 6.8%.

In addition, the use of a Likert-type questionnaire to assess students' technological competencies has allowed a detailed view of their perceptions of their ability to handle technological tools. This methodological approach, adapted from Llorente Cejudo and Cabero Almenara (2010), has proven to be effective in identifying areas for improvement in the knowledge and use of ICTs. However, it should be considered that self-assessment may be subject to personal biases, which could be influencing the interpretation of these results. It has already been mentioned in the literature that self-perception of mastery does not always coincide with actual driving. Aesaert et al. (2017) reported a shortcoming and gap when exploring the relationship between the self-perception of efficiency and the real ICT competencies that students possessed. Such bias translates into a limitation of this research, limited to self-perceptions.

Although significant relationships were identified at the intramodel level, this was not appreciated at the variable level. The latter is not consistent with those reported in the existing literature where it is pointed out that, in the educational process, the mastery of ICTs can translate into better academic performance (Albó et al., 2019; Fonseca et al., 2021; Miguel-Revilla, 2020; Balladares-Domo et al., 2023; Antonietti et al., 2022).

However, it is crucial to highlight that the mere availability of ICTs does not guarantee an improvement in academic performance. The quality of teacher training in the use of these tools is a determining factor that influences the effectiveness of their implementation in the classroom.

The AR metrics also have a contextual deficiency, since there was no information available to specify what type of methodology had been applied and whether it required the use of ICTs beyond the daily use. Albó et al. (2019) have pointed out the favorable impact of the use of social networks on students' autonomous learning, something typical of digital natives, but this was not investigated and the thesis of natives (Kirschner & De Bruyckere, 2017) still needs to be validated in this group.

The results do not necessarily translate into fatalism. It must be considered that the evolutionary route of incorporation of ICTs in the post-pandemic phase has been accelerated, but it has not gone hand in hand with the demands and dynamics of technology. Technological education in Ecuador is basically aimed at subjects from the most economically disadvantaged strata. This would also be a conditioning factor to be explored. Despite all the potential benefits, the integration of ICT into tertiary technical education faces several challenges. It would be necessary to consider whether there are infrastructure and resource gaps (Lai & Bower, 2020), and review the levels of preparation of the teaching staff (Sánchez-Prieto et al., 2019).

Additionally, it would be advisable to explore the degree of alignment between pedagogical requirements and the use of ICTs (Bond et al., 2020). All of the above could be influencing the identified digital divide, since the disparities inherent in digital literacy and students' access to technology can lead to educational inequalities (Rasheed et al., 2020).

On the other hand, it would be necessary to see where teaching practice stands in terms of the integration of ICTs in tertiary technical education, since this system has recently undergone a transformative process that has reconfigured traditional teaching and learning paradigms (Fernández-Batanero et al., 2021).

For example, it would be necessary to consider whether areas such as the implementation of Learning Management Systems (LMS) that are mandatory these days (Aldiab et al., 2019; Chen et al., 2019); the use of simulation and modeling software, fundamental in the field of technical (Kapilan et al., 2021); cloud-based collaborative tools and collaborative project management (Hernández-de-Menéndez et al., 2020; Deng et al., 2019); augmented and virtual reality (AR/VR), aimed at generating immersive learning experiences (Martín-Gutiérrez et al., 2017) and mobile learning, where they appreciate the benefits of using smartphones and tablets for pedagogical purposes (Crompton & Burke, 2018; Antonietti et al., 2022; Damşa et al., 2021).

In this sense, this work serves as a beginning to continue exploring the complex field of teaching and learning in technical and technological education. The gaps require an institutional response, but also student awareness, in order to correct them. From the infrastructure and infostructure component, to the pedagogical alignment and teaching action, there is still much to work on and promote.

CONCLUSION

In conclusion, this research provides valuable evidence on the importance of ICTs in tertiary technical education and training. Prevailing average levels were identified in terms of mastery of technological tools, which makes the existing gap visible. It was also noted that the complexity of the tasks is not accompanied by a good level of technological mastery, but on the contrary increases the low percentages of technical mastery.

There was no evidence of a relationship between the level of ICT proficiency and academic performance. This contradicts the existing theory, and forces the generation of broader research, where contextual and curricular factors are explored, as well as teacher training, the demands of the microcurriculum and the component of information and institutional infrastructure.

Among the recommendations is the urgency of taking action to ensure teacher training and the inclusion of technologies in the curriculum. As we move towards an increasingly digital and AI-mediated world, it is imperative that institutions are aware of, recognize, and address these needs to prepare students for the challenges of the future of work. The implication of these findings is clear: to optimize the teaching and learning process in similar educational contexts, it is essential not only to integrate ICTs into the curriculum, but also to ensure that teachers are adequately prepared to use them effectively. This will not only improve students' academic performance, but will also foster a more dynamic and participatory learning environment.

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