

RECURSOS DIGITALES INTERACTIVOS EN EL PROCESO DE INTERAPRENDIZAJE EN EL ESTUDIO DE LA CONTABILIDAD

DIGITAL INTERACTIVE RESOURCES IN THE INTERLEARNING PROCESS IN THE STUDY OF ACCOUNTING

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RESUMEN

Este estudio tiene como objetivo investigar el efecto de los recursos digitales interactivos en el proceso de aprendizaje colaborativo de la contabilidad entre noventa estudiantes del tercer semestre de la carrera de Contabilidad. Emplea métodos tanto cuantitativos como cualitativos. Se realizó una encuesta a los estudiantes de tercer semestre utilizando tecnologías digitales interactivas. En el estudio se utilizaron estadísticas descriptivas, análisis de agrupamiento, análisis de matrices (IPMA) y análisis de correlación. El análisis destaca que los estudiantes utilizan tecnologías como simuladores, software de contabilidad y plataformas gamificadas en las actividades de clase. Estas herramientas ayudan a motivar a los estudiantes, enseñar conceptos, promover el trabajo en equipo y desarrollar habilidades prácticas. Los resultados muestran una alta percepción de la eficacia de los recursos digitales interactivos en cuanto a la motivación (72 %), el aprendizaje significativo (68 %) y el aprendizaje colaborativo (80 %). Además, el análisis de agrupamiento y de correlación indica una fuerte relación entre la relevancia profesional percibida y el desempeño en el aprendizaje ($\rho = 0,87$, $p < 0,01$). Por otra parte, en relación con los fundamentos teóricos del constructivismo social de Vygotsky y la Zona de Desarrollo Próximo, la interacción social es un factor determinante en el aprendizaje. En conclusión, el uso de recursos digitales interactivos optimiza la educación en contabilidad y prepara a los estudiantes para las exigencias del mercado laboral actual.

Palabras clave: aprendizaje, interactividad, recursos, tecnología, contabilidad

ABSTRACT

This study aims to examine the effect of digital interactive resources on the interlearning process in accounting among ninety students in the third semester of the Accounting degree program. It employs both quantitative and qualitative methods. It surveyed third-semester students using digital interactive technologies. Descriptive statistics, analysis of clustering, matrix analysis (IPMA), and correlation analysis were used in the study. The analysis emphasizes that students use technologies such as simulators, accounting software, and gamified platforms in classroom activities. These tools help motivate students, teach concepts, promote teamwork, and develop practical skills. Results show a high perceived effectiveness of digital interactive resources in motivation 72%, meaningful learning 68% and collaborative interlearning 80%. Further, cluster and correlation indicate a strong relationship between perceived professional relevance and learning performance ($\rho = 0.87$, $p < 0.01$). Besides, in relation to the theoretical basis of social constructivism of Vygotsky and the Zone of Proximal Development, social interaction is a determining factor in learning. As a conclusion, the use of digital interactive resources optimizes the accounting education and prepares the students for the demands of today's job market.

Keywords: learning, interactivity, resources, technology, accounting

INTRODUCTION

Advances in technology have brought substantial changes in education. The use of technology in education is very useful because it increases the ability to transform teaching and learning processes. Over the years, several international institutions, in particular UNESCO (United Nations Educational, Scientific, and Cultural Organization), have highlighted the valuable contribution of technological processes and digital tools in education (UNESCO, 2023). Furthermore, technology is thought to contribute to the development of digital skills that would enhance critical thinking, problem-solving, and independent learning. Mdhlalose and Mlambo (2023) also argue that the integration of technology in the classroom expands the academic and intellectual horizons, thereby making the teacher-student relationship more effective.

The Ecuadorian Ministry of Education is promoting the use of interactive resources in the accounting learning process since it provides students with essential practical skills that allow them to perform better in business and professional settings in institutions of different types and sizes (Caguana et al., 2025). This important strategy responds to the business demand for better-trained young people with digital skills that are essential in the labor market, which is in line with the IDB Lab's program to improve cybersecurity and youth employment in

Panama, which focused on developing technical, soft, and socio-emotional skills (Martinez & López, 2020).

In this context, interactive resources provide students with the opportunity to work with real-world data and simulations very similar to the workplace. The digital age has transformed the business world by automating repetitive tasks, so students need to be trained in digital environments to develop professional-level skills and prepare them to meet the demands of today's job market (Morales & Jiménez, 2021). Thus, the use of interactive resources such as digital platforms, Quizizz, and different accounting software provides a wide range of possibilities for the development of skills and competencies in key areas of the accounting profession (Calderón, 2025).

The use of interactive digital resources for teaching is highlighted by several authors because they favor meaningful learning, curiosity, and critical thinking. Today, in accounting, activities are created closer to the real world through the resolution of cases or situations directly linked to the business environment (Corro et al., 2024). The development of activities with interactive resources, in turn, favors continuous participation and motivation in the classroom (Manotoa et al., 2025). The study mentions that the purpose of this academic article is to analyze the contribution of the use of interactive resources in the learning process of university students in Accounting.

METHODOLOGY

This research was done using mixed methods by combining quantitative and qualitative data (Hernández & Mendoza, 2018). For the quantitative analysis, a structured survey was applied with 10 items, each one related to specific dimensions in the use of digital interactive resources used in accounting education (motivation, conceptual understanding, teamwork, information retention, among others) (Mata, 2019). These items were rated on a five-point Likert scale (from highly effective to ineffective). A pilot test was applied before administration, using the same 25 students who were included in the study sample; hence, no external pilot testing was performed, using a global Cronbach's alpha of 0.95, showing high reliability.

Qualitative method: It was used with perceptions, and they were collected through observations and student feedback during the gamified activities. A more rigorous investigation will be to develop clear analytical categories (e.g., intrinsic motivation, perception of practical utility, social interaction, and self-perception of achievement), which will give us a deeper understanding of students' experiences (López & Ramos, 2021). Descriptive statistics and a hierarchical clustering study validated with the silhouette index were developed using RStudio software. The overall value obtained was approximately 0.23, which showed a moderate internal separation. In future investigations, it is recommended to define more robust

criteria for interpreting the utility of clustering, considering both the stability of the groups and their pedagogical importance.

RESULTS

The following presents the results of a survey administered to third-semester students in the Accounting and Auditing program regarding the use of interactive resources in the accounting learning process. They were considered interactive resources: simulations, laboratory assignments, accounting software, and the use of interactive quizzes.

Table 1

Effectiveness in the use of interactive resources

Category	Frequency	Percentage
Highly effective	54	60%
Moderately effective	27	30%
Neutral	6	7%
Not very effective	2	2%
Not effective	1	1%
TOTAL	90	100%

Note. The data show the survey results regarding the effectiveness of interactive resources.

Regarding the effectiveness of interactive resources, most students consider them to be either highly or moderately effective; a smaller proportion considers them to be ineffective.

Table 2

Interactive Resources for Collaborative Learning in Accounting

Category	Frequency	Percentage
Highly effective	72	80%
Moderately effective	14	15%
Neutral	3	3%
Not very effective	1	1%
Not effective	1	1%
TOTAL	90	100%

Note. The data show the results of the survey regarding the effectiveness of the use of interactive resources.

When considering a series of activities using various tools as interactive resources, students generally rated them as highly or moderately effective; a smaller proportion considered them to be somewhat ineffective in the accounting teaching-learning process, based on the continuous interaction between the instructor and students, which promotes knowledge construction.

Table 3

Interactive resources for meaningful learning

Category	Frequency	Percentage
Highly effective	61	68%
Moderately effective	24	27%
Neutral	5	5%
Not very effective	0	0%
Not effective	0	0%
TOTAL	90	100%

Note. The data show the results of the survey regarding the effectiveness of interactive resources.

When asked to evaluate interactive resources as tools that contribute to meaningful learning, a high percentage of students rated them as highly or moderately effective, with a smaller proportion rating them as neutral. This suggests that students believe that learning through interactive resources promotes active learning, in which students participate and are at the center of the educational process.

Table 4

The effectiveness of interactive resources

Category	Frequency	Percentage
Highly effective	65	72%
Moderately effective	14	15%
Neutral	7	8%
Not very effective	3	3%
Not effective	2	2%
TOTAL	90	100%

Note. The data show the survey results regarding the effectiveness of interactive resources.

Regarding the use of interactive resources, a high percentage of students indicated that they serve as a motivating factor. A smaller proportion indicated that they consider them ineffective. Interactive resources encourage experimentation and interaction through firsthand manipulation and observation of results.

Table 5

Use of interactive resources to aid in understanding concepts

Category	Frequency	Percentage
Highly effective	49	54%
Moderately effective	32	36%
Neutral	8	9%
Not very effective	1	1%
Not effective	0	0%
TOTAL	90	100%

Note. The data show the survey results regarding the effectiveness of interactive resources.

Regarding conceptual understanding, most respondents consider them to be highly or moderately effective; a smaller proportion considers them to be neutral or somewhat ineffective. The use of interactive resources helps stimulate multiple senses with images, text, audio, videos, animations, etc.

Table 6

Use of interactive resources for teamwork

Category	Frequency	Percentage
Highly effective	50	55%
Moderately effective	25	28%
Neutral	14	16%
Not very effective	0	0%
Not effective	1	1%
TOTAL	90	100%

Note. The data show the results of the survey regarding the effectiveness of interactive resources.

When asked about the use of resources and their role in promoting teamwork, a large proportion of students indicate that using these tools leads to a high level of teamwork.

Table 7

Use of interactive resources for concept retention

Category	Frequency	Percentage
Highly effective	49	54%
Moderately effective	30	33%
Neutral	11	12%
Not very effective	1	1%
Not effective	0	0%
TOTAL	90	100%

Note. The data show the results of the survey regarding the effectiveness of interactive resources.

When asked about the use of interactive resources for retaining concepts in accounting, most students consider them to be highly or moderately effective tools in the teaching-learning process.

Table 8

Use of interactive resources for developing accounting skills

Category	Frequency	Percentage
Highly effective	59	66%
Moderately effective	22	24%
Neutral	9	10%
Not very effective	0	0%
Not effective	0	0%
TOTAL	90	100%

Note. The data show the survey results regarding the effectiveness of using interactive resources.

Regarding accounting skills, respondents consider the development of accounting skills using interactive resources in the teaching-learning process to be highly or moderately effective.

Table 9

Use of interactive resources in classroom activities

Category	Frequency	Percentage
Highly effective	60	67%
Moderately effective	22	24%
Neutral	8	9%
Not very effective	0	0%
Not effective	0	0%
TOTAL	90	100%

Note. The data show the survey results regarding the effectiveness of interactive resources.

When asked if they would recommend the use of interactive resources, a high proportion of students considered them to be highly or moderately effective for their use and development during classroom activities.

Table 10

Types of digital interactive resources

Resources	Frequency	Percentage
Accounting Software	27	30%
Quizizz + Kahoot	21	23%
Various games	24	27%
Forums, blogs, wikis	18	20%
TOTAL	90	100%

Note. The data show the results of the survey regarding the effectiveness of interactive resources.

When asked about their preferred types of digital interactive resources, most students indicated that they prefer accounting software and tools such as Quizizz and Kahoot that allow for learning through play; a smaller proportion prefer forums, blogs, wikis, etc.

Clustering Analysis

A clustering analysis was conducted with 90 students using a 5-point Likert scale ranging from Highly Effective (5) to Not Effective (1)

For each of the tables (1 through 9), a vector of proportions across 5 categories was considered, along with a weighted average score: 5% Highly effective + 4% Moderately effective + 3% Neutral + 2% Not very effective + 1% Not Effective.

The average scores by dimension were obtained:

Table 11

Average Scores by Dimension

Dimensions	Mean
T1 Overall Effectiveness	4.46
T2 Inter Learning in Accounting	4.72
T3 Meaningful Learning	4.63
T4 Motivation	4.52
T5 Concept Understanding	4.43
T6 Groupwork	4.36
T7 Concept Retention	4.40
T8 Accounting Skills	4.56
T9 Classwork	4.58

Note. The table shows the scores measured by dimensions.

In this case, all dimensions are in a high range of 4.36/5 or higher.

Dimension clustering

A 9x5 matrix is constructed with proportions of the categories (A-M-N-P-No).

Distance: Hellinger (robust for compositions); results consistent with Euclidean in this dataset.

Algorithm: Ward's hierarchical clustering, validated with silhouette, and cut off by stability.

Defined clusters:

Cluster 1: Extremely high impact with profiles marked by "Highly effective" in the absence of negative responses:

Table 12

Cluster 1: Highly Effective

Dimensions	Mean
T2 Inter Learning in Accounting	4.72
T3 Meaningful Learning	4.63
T4 Motivation	4.52
T8 Accounting skills	4.56
T9 Classwork	4.58

Note. The table shows the highly effective clusters.

Table 13

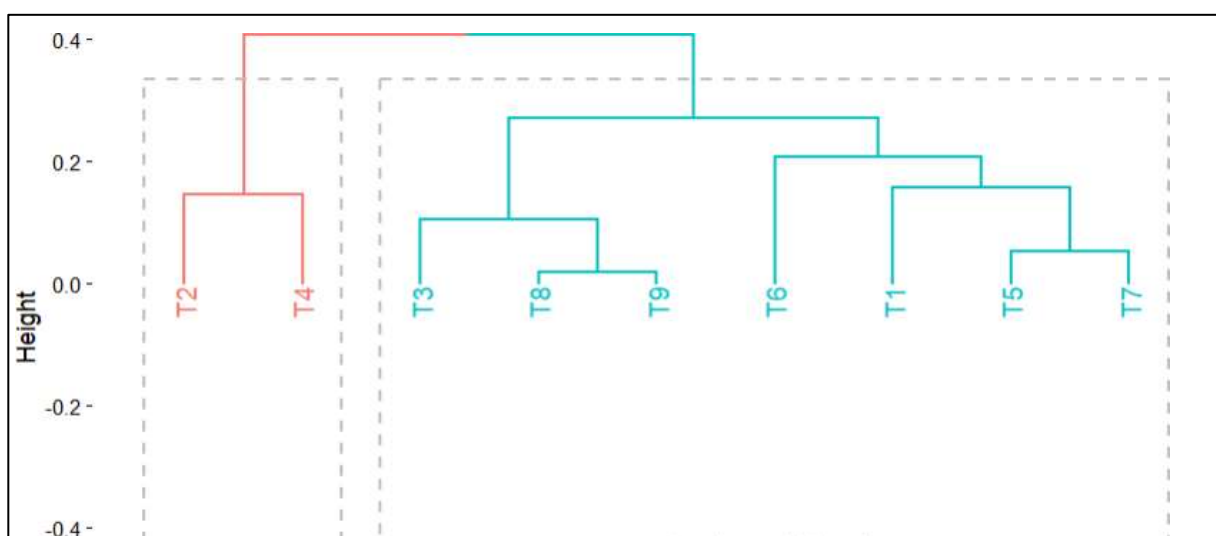
Cluster 2: High impact but with a higher proportion of moderate/neutral responses

Dimensions	Mean
T1 Overall Effectiveness	4.46
T5 Concept Understanding	4.43
T6 Groupwork	4.36
T7 Concept Retention	4.40

Note. The table shows clusters with moderate to neutral responses

Figure 1

Dendrogram of variables (Hellinger y Ward)



Note. Created using RStudio software for cluster analysis.

Student's segmentation

Standardization by item

k-medoids (k=3) all compare k= 2.5 per silhouette

Estimated cluster

C1 Motivated 58-65%; 52-59 students

Indicate Highly effective in most dimensions, with a moderated average score of 4.7, with the highest concentration in T2, T9 y T3

C2 Moderated 28-33% 25-30 students

In order to determine the optimal number of clusters, different solutions were evaluated, k=2, k=3, and k=4, using the silhouette index as a validation criterion. The comparison provided as k=2 as the most appropriate clustering structure, considering a higher average

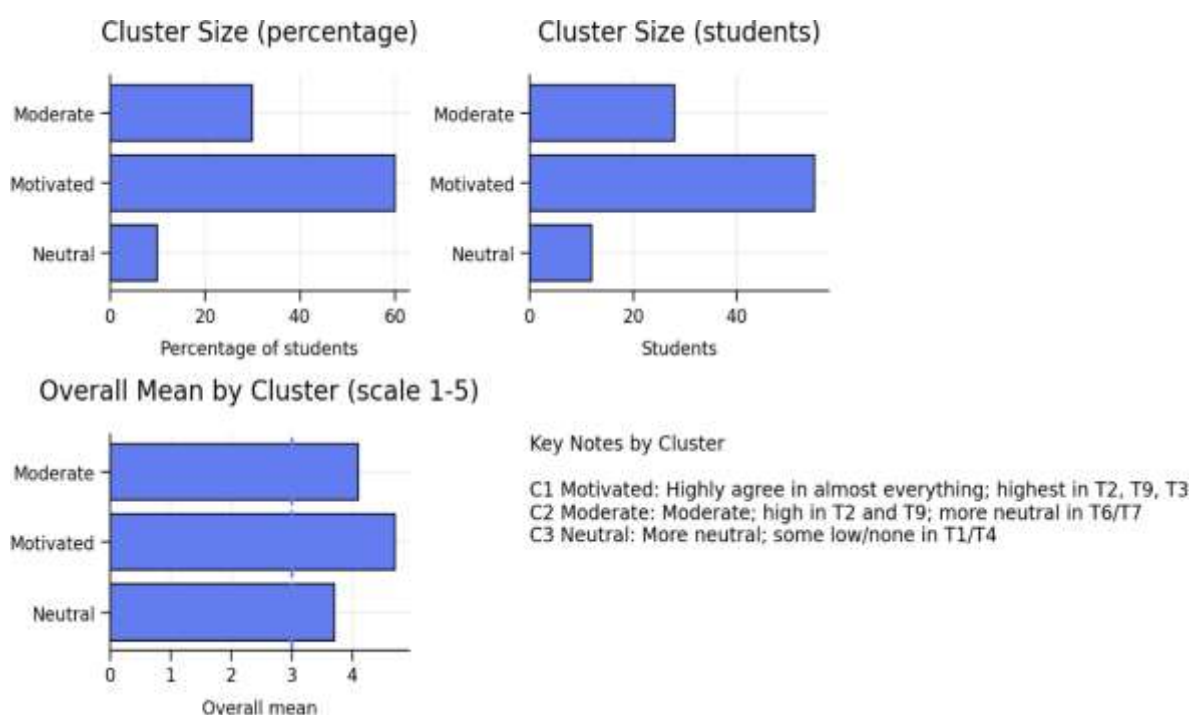
silhouette value compared to the other configurations. Hence, $k=2$ was selected as the final model.

Indicates moderately effective to highly effective in areas such as T2 and T9; with greater neutrality in T6/T7, yielding an overall average of 4.1 to 4.3.

C3 Neutrals 7–10% 6–9 students' higher proportion of neutral responses and, in some cases, "Little" or "No" responses regarding motivation and overall effectiveness. Overall mean 3.6 and 3.9.

Figure 2

Clusters and their sizes by student segmentation



Note. Created using RStudio software for cluster analysis.

For data validation, PAM with Gower distance (for ordinal data) was used. Internal quality was evaluated using the silhouette index, yielding an overall average value of 0,23. It shows a moderate clustering structure. Stability was estimated using Bootstrap (clusterboot).

Data Validation

Table 14

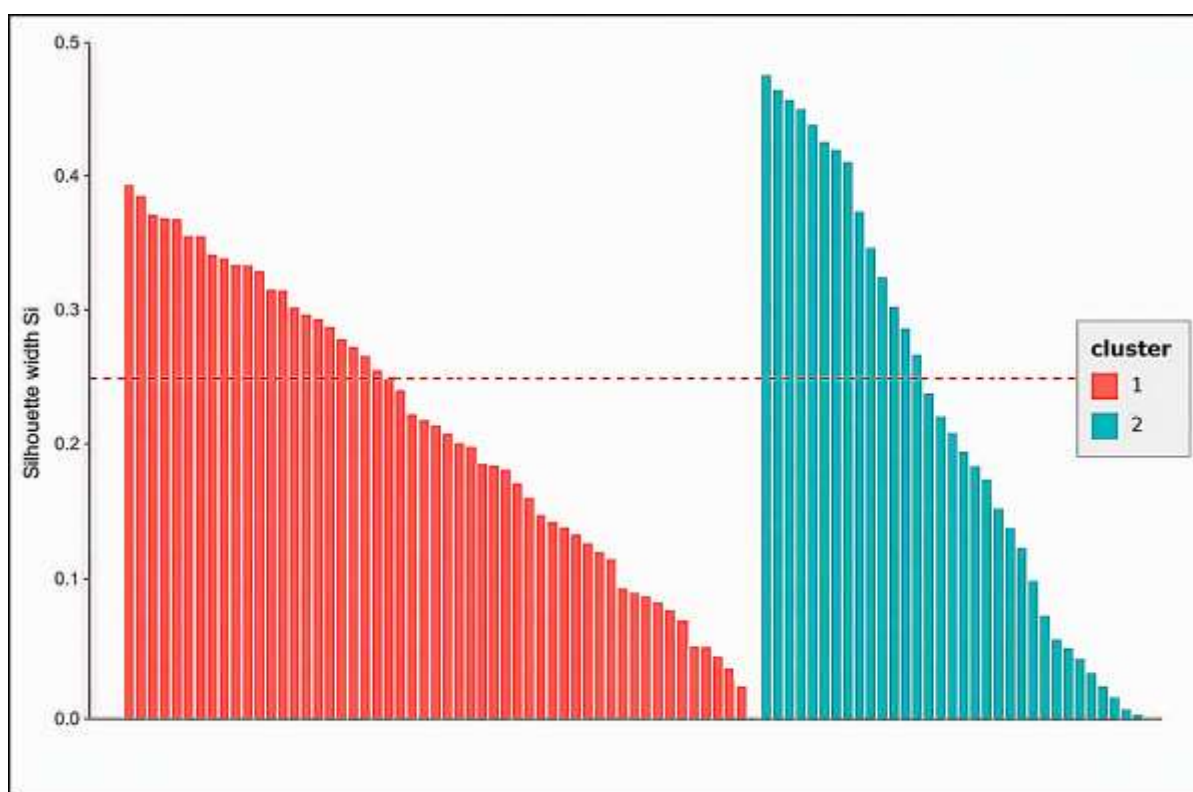
Internal Validation R Studio

```
pam_g2 <- pam(D_gower, k = 2, diss =
pam_g2$silinfo$avg.width # silhouette medio global
[1] 0.2306632 # resumen por clúster e individual
Silhouette of 90 units in 2 clusters from pam(x = D_gower, k = 2, diss =
TRUE) : Cluster sizes and average silhouette widths:
        65      25
```

Note. The table shows the validation results generated by R Studio.

Figure 3

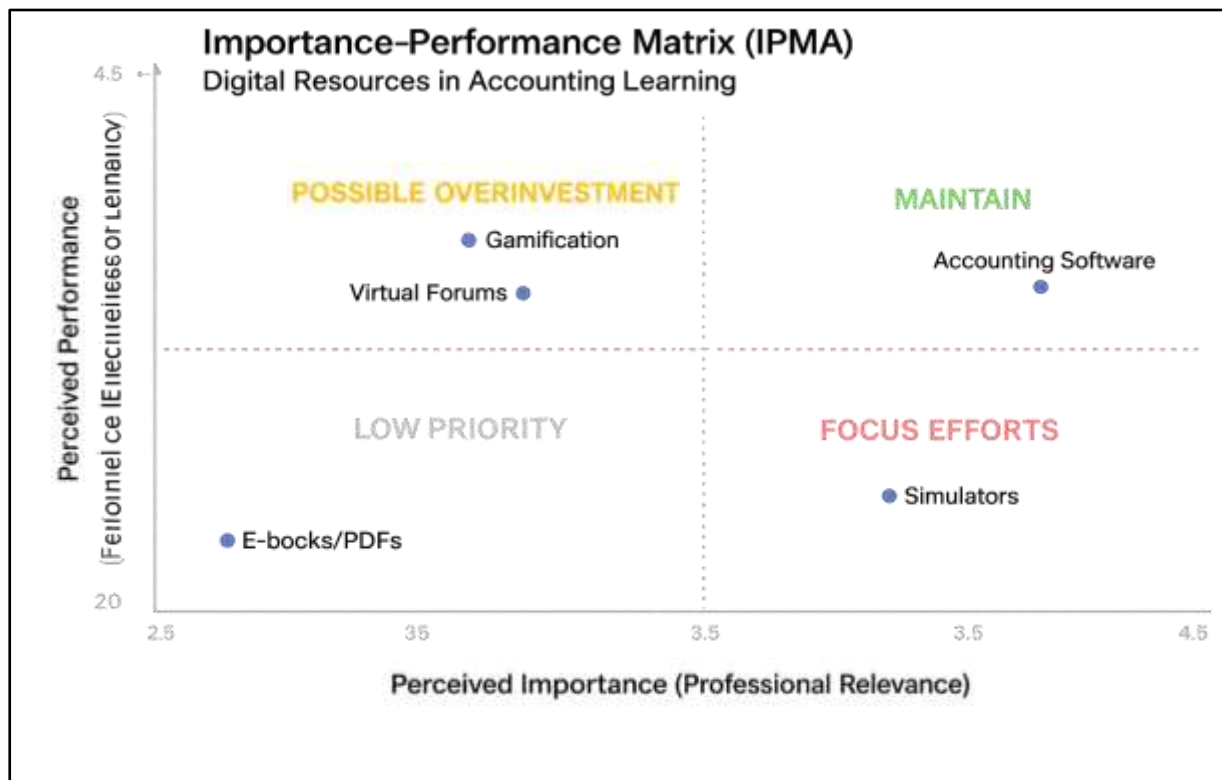
Silhouette by student



Note. The figure shows internal clustering evaluation with $k = 2$.

Figure 4

Performance and Importance Matrix



Note. The figure shows the Performance and Importance Matrix.

Spearman's rank correlation rho

data: importance and performance

S = 20.758, p-value = 0.0009391

Alternative hypothesis: true rho is not equal to 0

sample estimates:

rho 0.8741914

5. Interpretation

cat("Coeficiente Rho de Spearman:", result_spearman\$estimate, "\n")

Coeficiente Rho de Spearman: 0.8741914

cat("Valor p (Significance):", resultado_spearman\$p.value, "\n")

Value p (Significance): 0.0009390746

DISCUSSION

The results reveal a positive analysis of digital interactive resources by students, aligned with Vygotsky's social constructivism (Parra et al, 2022) and Jonassen's work on technology-mediated learning. These tools motivate, promote conceptual understanding, and help develop practical skills.

It is necessary to reinforce a critical analysis, though:

Vygotsky's Theory states that learning occurs through social interaction within the Zone of Proximal Development (ZPD). This analysis shows that digital interactive resources are intermediaries which increase that process (Rigopouli et al, 2025).

The data demonstrates that 80% of students rate the instructor-student interrelation using technology tools as highly effective, suggesting an evolution of a traditional concept: interaction is not just human-to-human, but a triad consisting of a student-interface-professor.

The results suggest that 67% of students suggest that technological tools for teamwork assure that technology does not replace the social students' environment; instead, this is looking to transform the classroom into an interlearning environment where peer relationships are important.

On the other hand, Jonassen criticized rote learning and encouraged technology as mind tools. These results give a rigorous empirical validation of this stance (Samanta & Mudi, 2024). The study showed that 68% of students perceive meaningful learning when they apply digital interactive resources. These findings challenge the traditional accounting way of teaching based on repetitive recording. By using simulators and accounting software, the students change their spectator role to the main actor who manipulates real-world data.

Finally, these results should be studied as preliminary, not definitive conclusions. To ensure the inferential validity of the study, it is necessary to expand the sample and to reinforce the qualitative elements.

Clustering had some exploratory values but moderate internal separation (global silhouette ~0.23). It is necessary to apply a criterion for its evaluation that goes beyond statistical measures and relates to pedagogical importance. It serves as a critical warning that Jonassen would adopt technology alone and does not guarantee success. There are 7-10% of neutral students for whom the resources failed to break the barrier of conceptual understanding. It suggests that technology without a pedagogical plan can generate frustration instead of knowledge.

UNESCO maintains a frequently skeptical perspective regarding the excessive reliance on digital tools; this study shows almost zero resistance from the students; almost 66% of students said that these tools are too important to acquire skills in the current labor market (UNESCO, 2023).

The Importance-Performance Matrix Analysis (IPMA) and Spearman's rank correlation give a robust statistical foundation to evaluate digital resources in the accounting interlearning

process. As shown in Figure 4, the important position of interactive tools reveals a high alignment between professional expectations and pedagogical outcomes.

The Spearman's Rho coefficient ($\rho = 0.87$, $p < .001$) shows a strong, positive, and significant correlation between the perceived importance of digital resources and the students' learning performance. This high degree tells us that when students recognize the professional utility of a tool such as accounting software or a simulator, their cognitive engagement and mastery of the resource increase proportionally. This research validates the Social Constructivism background, where the objective of the activity (professional relevance) is a catalyst for the internal knowledge construction (Mojica, 2020).

Further, the IPMA is a complement to identify the most resources that fall within the Keep up the good work quadrant. This high performance/high importance makes a constructive collaboration, in contradiction to the more cautious point of view from UNESCO (2023). In the specific field of accounting, technology is not a distracting accessory, but a disruptive necessity. The data show that students do not suffer from technological frustration if the tools are perceived as important for their future job abilities.

CONCLUSION

This academic article reaches the conclusion that the digital interactive tools motivate exploration and engagement by letting users manipulate objects and observe the outcomes. The use of simulators, accounting software, and gamified platforms is shown as greatly relevant as a pedagogical strategy, related to the demands of the actual job market.

However, results should be interpreted with caution. A pilot test Cronbach's alpha = 0.95, internal validation of the clustering) was conducted; limitations still exist that restrict the inferential scope of the results. In particular, we emphasize (a) the lack of a detailed report on the questionnaire items, (b) the poor development of the qualitative part, (c) the limitation of the sample to a single organization and education level, and (d) the moderate quality of the clustering (global silhouette ≈ 0.23), which limits the robustness of the conclusions. Similarly, responses could have been impacted by self-perception bias, which could have decreased the objectivity of the data collected.

Thus, despite the results confirming the pedagogical utility of the interactive resources, future research should consider the complete items of the instrument and the development of more rigorous qualitative categories. This is the only way in which it will be possible to strengthen the validity and generalizability of the results, and to position interactive technology as a disruptive force in accounting education.

The empirical evidence through RStudio gives a quantitative validation of Vygotsky's socio-cultural theory. The professional relevance is as a catalyst that drives the student to pass the Zone of Proximal Development (ZPD). According to this, the high correlation between importance and performance gives us an important idea about how the perceived utility of digital tools in the labor market acts as the scaffolding necessary for students to transition from the skill level to the advanced competencies needed by the accounting professional.

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Conflict of Interest

There are no conflicts of interest.

Authors' Contributions

C.G.M.M.: conceptualization, formal analysis, data curation.

M.A.Z.A.: methodology, investigation, writing – original draft and writing – review and editing.

Ethical Statements

Institutional authorization: Authorization was obtained in order to carry out the presentation during the Congress.

Informed consent: Participants were informed about the purpose of the study and it was voluntary.

Confidentiality: The information was treated with strict confidentiality and used only for academic purpose.

Anonymization: The data were anonymized.

Ethical approval

This study did not require approval from ethics committee; however it followed ethical principles such as voluntary participation and confidentiality.