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ORIGINAL

Teaching Human Anatomy in Health Sciences through Information and Communication Technologies

La enseñanza de la Anatomía Humana en Ciencias de la Salud a través de las Tecnologías de la Información y la Comunicación

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ABSTRACT

Introduction: application of information and communication technologies (ICT) in the teaching of Human Anatomy and Physiology within Health Sciences programs.
Objective: to analyze the outcomes of a second experiment evaluating the contribution of ICT to teaching and their impact on the academic performance of students enrolled in Human Anatomy and Physiology courses within a Health Sciences degree program.
Method: the study followed a quasi-experimental design with a longitudinal approach and mixed methodology. The population was made up of 658 first-year learners enrolled in a Health Sciences program, and the sample included 590 students from the same cohort. A random probabilistic sampling method was applied. Prior to data collection and after obtaining informed consent, two instruments were administered: assessment rubrics (for evaluation activities) and a closed, anonymous, multiple-choice questionnaire. Both instruments were reviewed, refined and validated by expert faculty members with extensive experience in teaching and research.
Results: the findings showed that variables such as motivation, content systematization and comprehension had a significant impact on academic performance, especially in the *Cases* group, where ICT were used more intensively. The most noteworthy result appeared in the final grades: for the *High-performance* indicator (scores above 6), the difference between the *Cases* and *Control* groups was approximately 31 %. Regarding the studied population, it was observed that 47 % of the students in both groups belonged to the age group over 30 years.
Conclusions: reflecting on academic performance —as the observable outcome of the variables studied— it can be argued that this is a direct consequence of the teaching-learning process. This process is influenced both by the learner's abilities, which are partly conditioned by age, and by the challenge faced by the education system promoting meaningful learning.

KEYWORDS

Information and Communication Technologies (ICT); Human Anatomy; Academic Performance; Student Perception.

RESUMEN

Introducción: aplicación de las tecnologías de la información y la comunicación (TIC) en la enseñanza de Anatomía y Fisiología Humana en programas de Ciencias de la Salud.
Objetivo: analizar los resultados de un segundo experimento que evalúa la contribución de las TIC a la docencia y su impacto en el rendimiento académico de los estudiantes de Anatomía y Fisiología Humana de un programa de grado en Ciencias de la Salud.

Método: el estudio siguió un diseño cuasiexperimental con un enfoque longitudinal y una metodología mixta. La población estuvo compuesta por 658 estudiantes de primer año de un programa de Ciencias de la Salud, y la muestra incluyó a 590 estudiantes de la misma cohorte. Se aplicó un muestreo probabilístico aleatorio. Previo a la recolección de datos y tras obtener el consentimiento informado, se administraron dos instrumentos: rúbricas de evaluación (para actividades de evaluación) y un cuestionario cerrado, anónimo y de opción múltiple. Ambos instrumentos fueron revisados, refinados y validados por profesores expertos con amplia experiencia en docencia e investigación.
Resultados: los hallazgos mostraron que variables como la motivación, la sistematización y la comprensión de contenidos tuvieron un impacto significativo en el rendimiento académico, especialmente en el grupo de Casos, donde se hizo un uso más intensivo de las TIC. El resultado más destacable se observó en las calificaciones finales: para el indicador de Alto Rendimiento (puntuaciones superiores a 6), la diferencia entre los grupos de Casos y Control fue de aproximadamente el 31 %. Respecto a la población estudiada, se observó que el 47 % del alumnado de ambos grupos tenía más de 30 años.
Conclusiones: al reflexionar sobre el rendimiento académico, como resultado observable de las variables estudiadas, se puede argumentar que este es una consecuencia directa del proceso de enseñanza-aprendizaje. Este proceso se ve influenciado tanto por las habilidades del alumnado, condicionadas en parte por la edad, como por el reto que enfrenta el sistema educativo para promover el aprendizaje significativo.

PALABRAS CLAVE

Tecnologías de la Información y la Comunicación (TIC); Anatomía Humana; Rendimiento Académico; Percepción del Alumnado.

INTRODUCTION

In view of the results obtained in the first study, the sample and the subjects under analysis were expanded. In this second stage, the application of information and communication technologies (ICT) was examined in the teaching of Human Anatomy and Physiology in undergraduate programs within the Health Sciences at a university in Buenos Aires. A major milestone in recent years, across all contexts, was the COVID-19 pandemic (2020). The global outbreak of the coronavirus led to a mandatory lockdown. Among the many disrupted activities, education was no exception, with institutions forced to close and adopt technological tools to continue teaching. Virtual learning environments emerged as a network of hypertextual Windows, enabling people to work, educate, teach, care for, and support others despite the imposed psysical distance.[1]
In response to the health emergency, various companies and organizations provided access to their digital platforms, repositories and applications containing hundreds of educational resources. The need to manage information and knowledge accelerated significantly with the swift and widespread adoption of ICT. This, in turn, required society to develop new skills related to automation, through the use of connectivity tools and access to wide range of learning platforms.[2]
Information and communication technologies (ICT) emerged from the need to accompany technological change —a process that has been documented in the academic literature for at least the past fifteen years— highlighting the convergence between technology and pedagogical tools, aimed at facilitating knowledge acquisition. Through these tools, educators and learners are able to create, edit, gather and store information in digital formats.[3] Innovation in teaching and learning —driven by ICT— has revealed a growing integration between the technological and educational spheres, a paring that helped overcome many of the challenges generated by the isolation imposed during the pandemic. This situation gave rise to new educational spaces, the use of previously underestimated instructional tools and a renewed appreciation for knowledge.[4]
Another key variable involves the number of students, who belong to different generations classified by their year of birth and defined by the historical context in which they were raised. Among the newest generational cohorts are Generation Y (also known as Millennials), born between 1982 and 1995; Generation Z (or Centennials), born between 1995 and 2000; Generation Alpha, born between 2010 and 2024; and the upcoming Generation Beta, which will include those born between 2025 and 2039. To date, there are no comprehensive studies that thoroughly explore how these generations engage with information technologies.[5,6] In light of the above, this study aimed to analyze the results of an experiment designed to evaluate the contribution of information and communication technologies to teaching and their influence on the academic performance of students in the subject Human Anatomy and Physiology, within Health Sciences programs. The study was carried out in two phases: the first, conduced in person[1] in 2019, has already been published; the second, held virtually, took place between 2020 and

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2022. This was a quasi-experimental study were undertaken with twenty-one class groups of the subjects Human Anatomy and Physiology between 2020 and 2022, with an average of approximately 31 students per group. In the groups defined as Cases (296 students), virtual classes were developed using the following resources: practical work guides, PowerPoint presentations, anatomy atlas plates, and systematically, the 3D Visible Body® anatomy software.[1] The same materials were used in the commissions corresponding to the control group (294 students); however, the use of the digital program was left to the student's discretion. The level of knowledge acquired in both subjects was assessed based on the results of individual midterm exams.

METHOD

The methodological design was quantitative, quasi-experimental and longitudinal. Participants were assigned to each group through random probabilistic sampling. The sample consisted of 590 students enrolled in Human Anatomy and Physiology courses, part of a Health Sciences program at a private university in Buenos Aires. Informed consent was obtained from each subject. Students who withdrew from the course, suspended their enrollment, declined to participate, or joined after the course had started were excluded from the sample.
For data collection, a construct previously validated in the first stage of the study was used, designed to measure the variables selected for this research. The instrument consisted of a rubric applied to the midterm exams, which was reviewed, adjusted and validated by subject-matter experts. The data were analyzed using multivariate methods and parametric statistical tests.

RESULTS

Out of a total sample of 590 students, the Control group had the highest percentage in the over 30 age range, as did the Cases group. Figure 1 and 2 present the results for the study group (n=296), based on the following indicators:

- Demonstrates lack of knowledge: In the first partial assessment 42,7 % were rated as Good, 40 % as Very good and 17,3 % as Fair. In the second instance, 48,3 % received a Very good rating, 30,7 % Good and 21 % Fair.
- Information retrieval: In the first assessment, 61,3 % were rated as Very good, 35,4 % as Good and 3,3 % as Fair. In the second assessment, 47,3 % received a Good rating, 36,7 % Very good, and 16 % Fair.
- In the Control group (n=294), for the same indicators, the results were as follows:
- Demonstrates lack of knowledge: In the first assessment, 49,8 % were rated as Good, followed by 36,8 % as Fair and 13,4 % as Very good. In the second assessment, 63,6 % were rated as Good, 31 % as Very good and 5,4 % as Fair.
- Information retrieval: In the first assessment, 70,3 % were rated as Good, 24,7 % as Very good and 5 % as Fair. In the second instance, Very good accounted for 46,7 %, followed by Good with 26,8 % and Fair with 26,5 %.

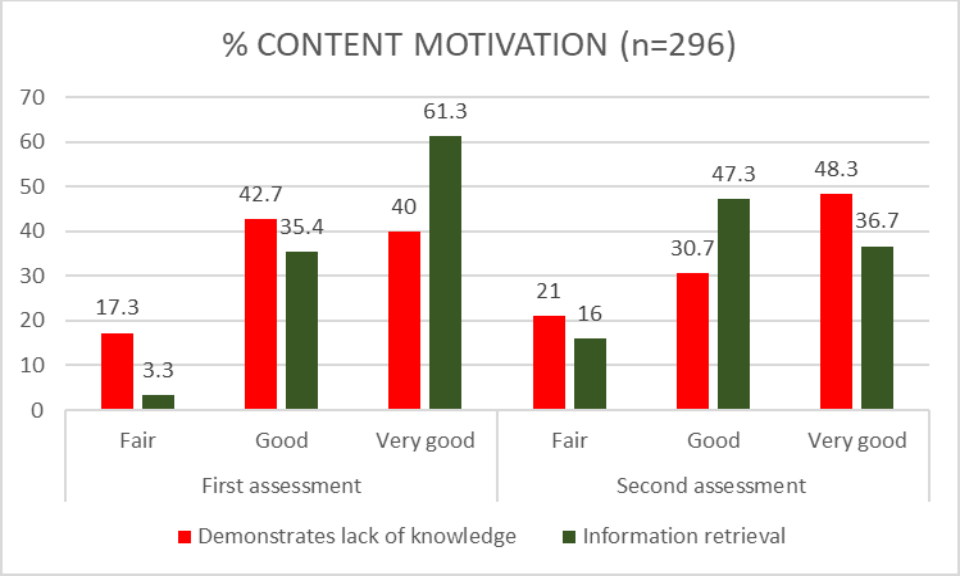

Figure 1. Frequency distribution by Content-related motivation in Cases group students enrolled in Human Anatomy from Health Sciences programs

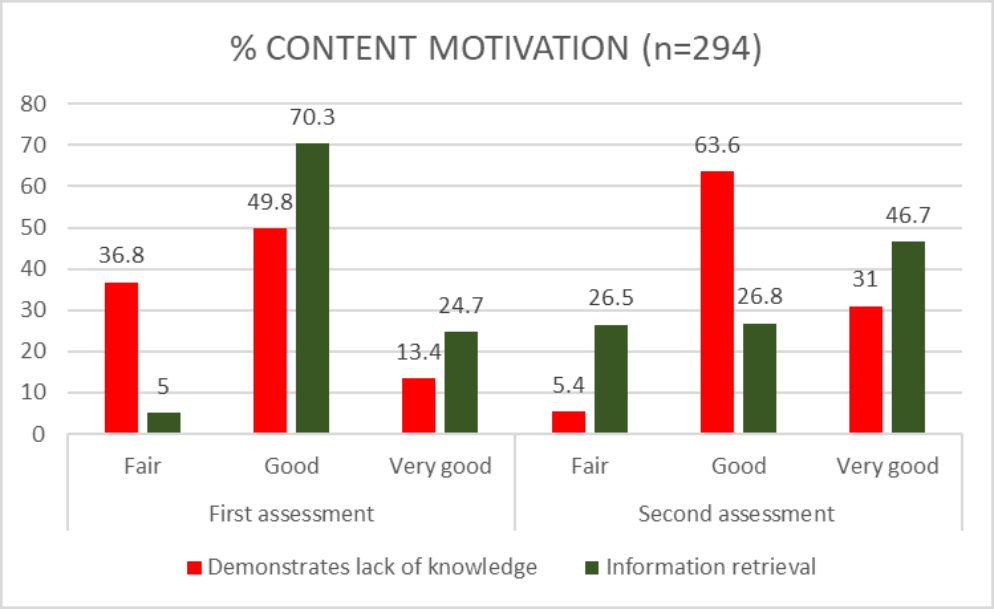

Figure 2. Frequency distribution by Content-related motivation in Control group students enrolled in Human Anatomy from Health Sciences programs

Figure 3 and 4 show that, in the Cases group, the indicators yielded the following results:

- Participation in integration activities: in the firt partial assesment 73,3 % obtained a Good rating, followed by 16,7 % Very good and 10 % Fair. In the second assessment, the highest percentage corresponded to Very good (53,4 %), followed by Good (43,3 %) and Fair (3,3 %).
- Use of interactive tools: in both the first and second assessments, the majority was rated as Very good, with 97,3 % in the first partial and 93,3 % in the second. Good accounted 6,7 % in the first assessment and 2,7 % in the second. No participants received a Fair rating.
- As for the Control group, the results were as follows:
- Participation in integration activities: Very Good was achieved by 66,7 % in the first partial assessment and 53,3 % in the second. Good accounted for 22,6 % in the first assessment and 46,7 % in the second. Fair represented 10,7 % in the first assessment, and no data were recorded in the second.
- Use interactive tools: In the first partial assessment, Fair was the predominant rating (80 %), decreasing to 55,3 % in the second. Good was obtained by 17,3 % in the first and 30 % in the second. Very good accounted for 2,7 % in the first and 14,7 % in the second.

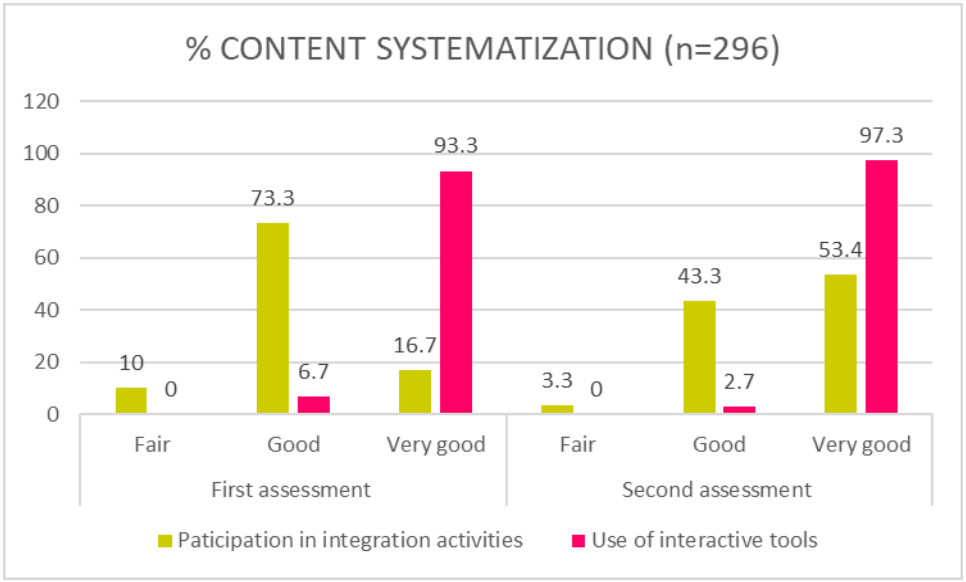

Figure 3. Frequency distribution according to Content systematization among Cases group students in Human Anatomy from Health Sciences programs

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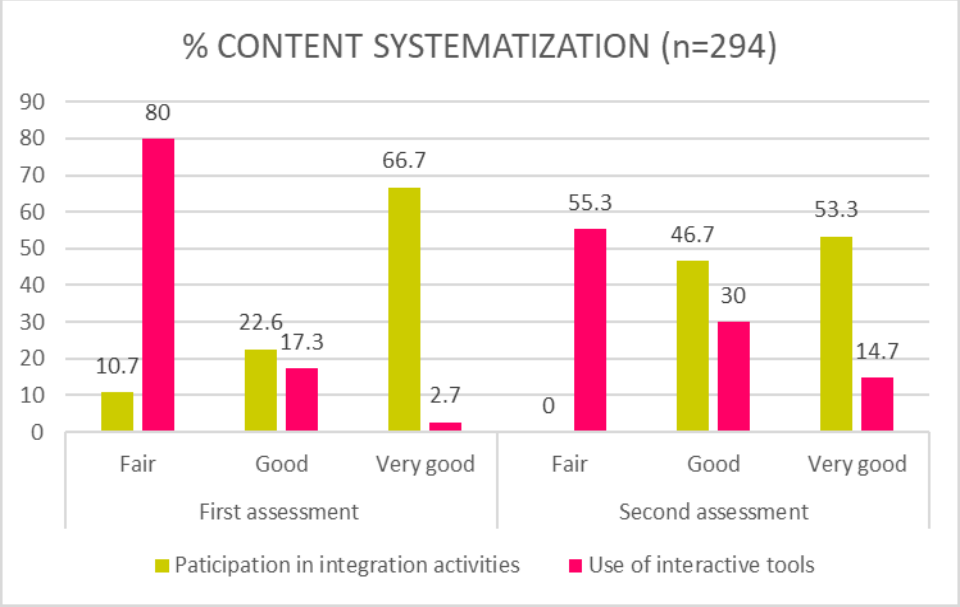

Figure 4. Frequency distribution according to Content systematization among Control group students in Human Anatomy from Health Sciences programs

Finally, in figure 5 and 6 the following was observed for the Cases group:

- Active listening, relevant contributions: In the first assessment, Good was reported at 74,3 %, and in the second assessment at 64,7 %. Very good reached 25,7 % in the first and 35,3 % in the second. No data were recorded in the Fair category in either assessment.
- Appropiate communication: in the second instance, Very good obtained 66,7 %, while Good received 64,3 % in the first instance. Good also recorded 33,3 % in the second instance and Very good 32,6 % in the first. Finally, Fair accounted for 10 % in the second instance and 3,1 % in the first.

In the Control group, the results were as follows:

- Active listening, relevant contributions: Good was recorded at 66,7 % in the first assessment and 73,4 % in the second. Very good reached 26,6 % in the first and 23,3 % in the second. Fair accounted for 6,7 % in the first and 3,3 % in the second.
- Appropiate communication: Fair reached 46,7 % in the first assessment and 53,3 % in the second. Good followed with 43,3 % in the first and 33,4 % in the second. Very good represented only 10 % in the first and 13,3 % in the second.

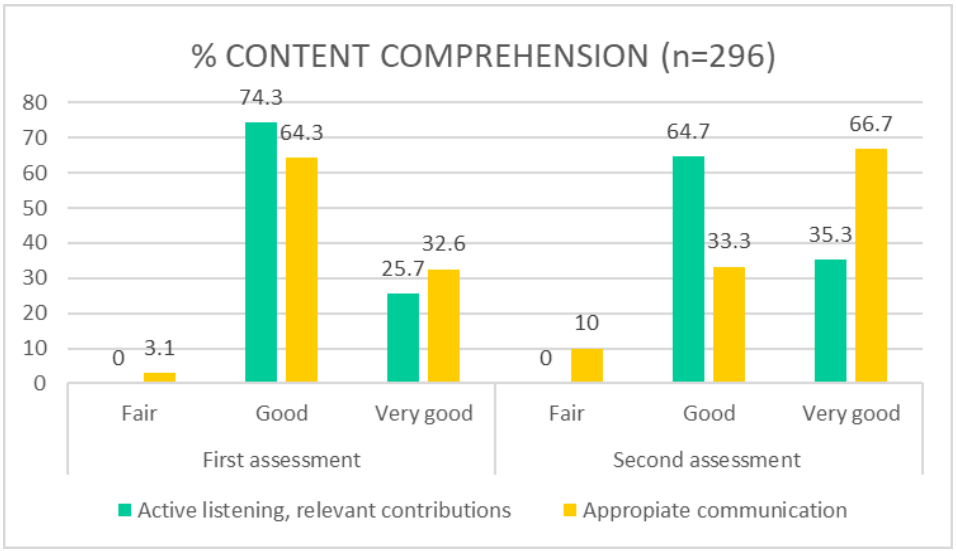

Figure 5. Frequency distribution according to Content comprehension among Cases group students in Human Anatomy from Health Sciences programs

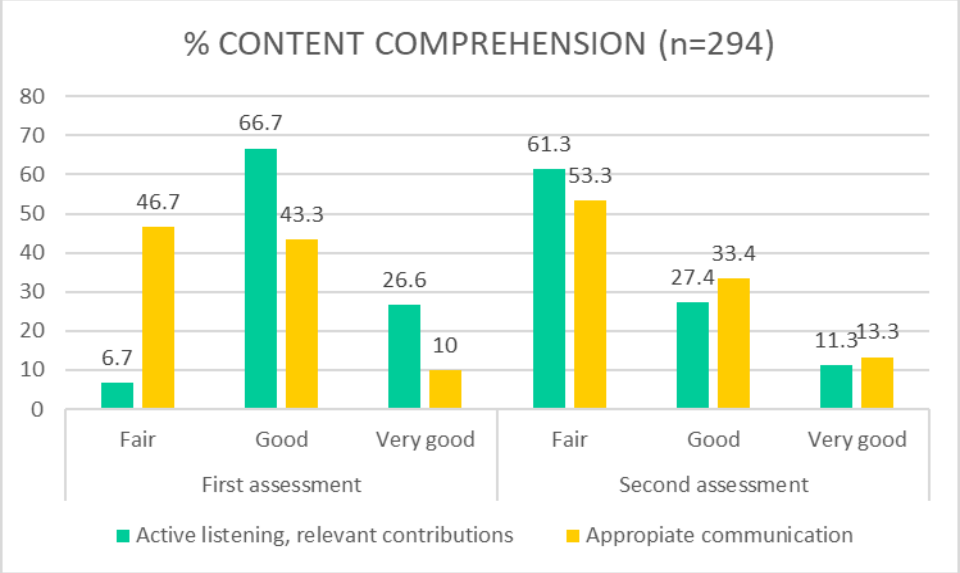

Figure 6. Frequency distribution according to Content comprehension among Control group students in Human Anatomy from Health Sciences programs

Finally, the Academic performance of the Cases group was 75,6 % in the High-performance category (over 6 points), in contrast with the Control group which obtained only 17,8 %. Regarding Medium performance (more than 3 to 6 points), the Control group achieved 44,02 %, while the Cases group recorded 21 %.

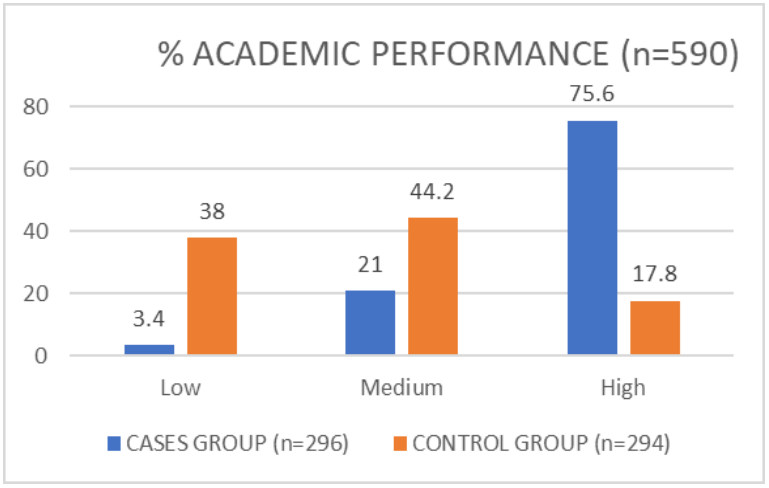

Figure 7. Frequency distribution based on final Academic performance of Cases and Control groups in the Human Anatomy course from Health Sciences programs

DISCUSSION AND CONCLUSIONS

Compared to the initial experience (2019), it is important to highlight that the behavior of the groups after the intervention was significant: students in the Cases group continued to use ICT and maintained the pedagogical dynamics developed during the study period.

This behavior was also reflected in Academic performance, which reached a High performance rate of 72 % in the post-intervention period.

This demonstrates that what initially began as an obligation —the use of interactive tools— ultimately led to their sustained integration and forested pupils'self-direct learning.[7,8]

With regard to the variables studied, it is observed that, for Content motivation, the Cases group reached a maximum of 48,3 % rated as Very good in the second partial assessment, specially in the indicator related to Demonstrate lack of knowledge. Meanwhile, the Control group reached 63,6 % rated as Good in the same indicator and assessment.

In relation to the Information retrieval indicator, the highest scores were recorded in the first partial assessment, with 70,3 % rated as Good in the Control group and 61,3 % as Very Good in the Cases group.

In relation to the second variable, Content systematization, the highest percentages for the indicator Participation in integration activities were observed in the first assessment: 73,3 % rated as Good in the Cases group, and 66,7 % for the same rating in the Control group.
For the indicator Use of interactive tools, the highest value recorded was 97,3 % in the Cases group (rated as Very good), while in the Control group the highest rating was 55,3 % in the Fair category, both corresponding to the second assessment.
Regarding the third variable, Content comprehension, the following results were obtained for the indicator Active listening, relevant contributions: the Cases group reached 74,3 % and the Control group 66,7 %, both rated as Good and corresponding to the first assessment.
Concerning the indicator Appropiate communication, the Cases group recorded 66,7 % in the Very Good category, while the Control group reached 53,3 % in Fair, both during the second assessment.
Finally, in terms of the variable Academic performance, the Cases group reached 75,6 % in the High category, compared to 44,2 % in the Medium category in the Control group.
With respect to the analysis of the measured variables, it can be observed that during the 2020-2021 period (virtual modality) and in 2022 (hybrid modality), the Control group was able to match some of the results obtained by the Cases group. This may be explained by the fact that the modality itself necessarily required the use of ICT.
It is also worth noting that the important age range in both groups was over 30, followed by the 20-30 range, and lastly those under 20.
A relevant milestone that became evidente during the virtual course was that the so-called “digital natives” showed strong skills in managing social networks, but struggled with basic office tools —such as Microsoft Office. Curiosity arose as the same questions kept appearing, such as: how to save a .doc file as a PDF, how to use an image editor to add labels, or how to attach a file to an email.
The way new generations learn is different; so are their needs, and today’s education has not envolved at the same pace as technology. In the educational process, the pursuit of meaningful learning has become the central focus, reinforcing self-directed learning. At the pedagogical level, various transformations and resources are been implemented to enhance the teaching environment.[9,10]
Today, educators face the challenge of recognising students from different generations in order to engage them through digital tools and support them in overcoming the specific challenges these tools pose for each group.[11]
For future work, we recommend a deeper analysis of the widespread use of social networks and how this phenomenon influences the development of truly meaningful learning.

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ETHICAL ASPECTS

The author declares that this article included consent from the study participants

CONFLICT OF INTEREST

The author declares no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Miana Vanesa Veronica.
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Supervision and visualization: Miana Vanesa Veronica.
Writing - review and editing: Miana Vanesa Veronica.