Igniting student engagement: H5P's transformative potential in higher education

Despertando el compromiso estudiantil: el poder transformador de H5P en la educación superior

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ABSTRACT

Student engagement is a key factor for success in online education, and there is a persistent need to identify and implement effective strategies to foster it, particularly in the increasingly common hybrid learning environments. Addressing this need, the present study evaluated the impact of interactive activities, designed using the H5P tool, on the engagement levels of 87 undergraduate students from two Ecuadorian universities. A quasi-experimental pretest-posttest design was employed to compare control and experimental groups. Data were collected through a 12-item questionnaire assessing cognitive, affective, and behavioral dimensions of engagement, supplemented by open-ended questions to gather qualitative data. The H5P intervention significantly improved cognitive aspects, such as concept understanding, knowledge application, and perceived depth of learning, as well as enjoyment; however, it did not significantly affect content relevance or collaboration. These findings suggest that while H5P can be a valuable tool for fostering specific components of student engagement, particularly cognitive and affective engagement, its effectiveness is limited when considered in isolation. Therefore, to maximize its impact, it is crucial to complement H5P with additional pedagogical strategies that actively promote collaboration, critical thinking, and connect the learning material with students' existing interests, experiences, and real-world applications. H5P offers considerable potential in online education, but requires a pedagogically informed, context-sensitive, and holistic approach. Future research is strongly recommended, employing rigorous experimental designs, larger and more diverse sample sizes, and multidimensional measurements of engagement, to provide deeper insights into optimizing the use of technology to effectively and sustainably foster all dimensions of student engagement, leading to improved learning outcomes.

Keywords: H5P; engagement; distance study; creation of teaching aids; educational technology.

RESUMEN

El compromiso estudiantil, clave para el éxito en la educación en línea, exige estrategias efectivas para fomentarlo, particularmente en entornos híbridos. Este estudio evaluó el impacto de actividades interactivas con H5P en el compromiso de 87 estudiantes de pregrado de dos universidades ecuatorianas, mediante un diseño cuasi-experimental pretest-postest con grupos control y experimental. La recolección de datos se realizó a través de un cuestionario de 12 ítems que abarcaba las dimensiones cognitiva, afectiva y conductual del compromiso y de preguntas abiertas. Los resultados sugieren que la intervención con H5P mejoró significativamente la comprensión conceptual, la aplicación del conocimiento, la profundización del aprendizaje y el disfrute de las actividades, aunque no se observaron efectos significativos en la relevancia percibida ni en la colaboración. Estos hallazgos indican que la efectividad de H5P es limitada si no se integra en un diseño instruccional estratégico más amplio. Se recomienda complementar la herramienta con estrategias pedagógicas que promuevan activamente la colaboración, la conexión del contenido con los intereses del estudiante y la adaptación al contexto, incluyendo enfoques como el trabajo en equipo, la especialización de contenidos, los debates basados en el material interactivo y la co-creación. Investigaciones futuras deberían emplear diseños experimentales con asignación aleatoria, muestras más amplias y diversas, y mediciones multidimensionales del compromiso, para optimizar el uso de herramientas tecnológicas en la promoción efectiva y sostenible del compromiso estudiantil en diversos contextos educativos.

Palabras clave: H5P; compromiso estudiantil; enseñanza a distancia; elaboración de medios de enseñanza; tecnología de la educación.

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INTRODUCTION

The virtual teaching-learning process in higher education faces the challenge of sustaining student interest and engagement. Student engagement and outcomes are decisively influenced by several factors, including course structure, instructor, teaching style, learning environment, and student characteristics (Mazman Akar, 2024; Taylor et al., 2018). This challenge requires the integration of educational technologies with effective instructional design embedded in innovative pedagogical strategies. Such integration should facilitate active learning and students' metacognitive reflection through timely and specific feedback on their strengths and weaknesses (Amhag, 2020; Baleni, 2015; Morris et al., 2021; Rahmi et al., 2024; Theelen & van Breukelen, 2022).

In particular, innovations in online education should prioritize pedagogical strategies that foster the active construction of knowledge, aligning seamlessly with key learning theories. Lamtara (2023) suggests a hybrid pedagogical strategy combining activities such as gamification, which incorporates playful elements and challenges, to increase student motivation and engagement by stimulating cognitive processes like attention, memory, and problem-solving. This aligns with cognitivist principles, which emphasize addressing diverse learning styles to foster meaningful learning (Mantuano et al., 2021; Parson & Major, 2020).

Meaningful learning experiences promote greater engagement, and diverse activities help sustain focus and prevent monotony (Kang & Furtak, 2021). This promotes the development of 21st-century skills, effective preparation for the job market, and the cultivation of motivated, reflective lifelong learners (Bailey et al., 2021; Bajaber, 2024; Kuh, 2009).

The outlined approach is consistent with cognitivist principles and can be further strengthened by incorporating pedagogical strategies such as project-based or problem-based learning. Moreover, activities promoting collaboration can facilitate the construction of knowledge networks, meaningfully connecting prior ideas and concepts—a key principle of connectivism (Downes, 2022; Ortiz & Corrêa, 2020; Safarifard et al., 2024) and sociocultural learning theories (Kang & Furtak, 2021). H5P (HTML 5 Package) emerges in this context as an innovative digital tool perfectly aligned with this approach, fostering interactivity and active participation. Integrable into platforms like Moodle, it allows teachers to design diverse activities, including quizzes, presentations, and interactive videos with immediate feedback.

As Ploetzner (2024) meta-analysis indicates, interactive learning videos significantly outperform simpler, navigation-only videos, offering more effective engagement and learning outcomes. From a physiological perspective, Gellisch et al. (2023) suggest that interactive online learning activities elicit stronger psychobiological responses in students than activities with limited or no interactivity. This level of psychobiological responses "is associated with greater attention and higher levels of engagement with both course work and learning material" (Gellisch et al., 2023, p. 11).

Fredricks et al. (2004) describe student engagement as a multidimensional construct encompassing behavioral, cognitive, and emotional aspects. Engagement involves observable behaviors such as class participation, persistence in challenging tasks, and an emotional connection to learning. Kuh (2009), on the other hand, emphasizes the importance of extracurricular experiences and connection to the university community in fostering engagement. Fredricks et al. (2004) and Kuh (2009) both confirm a positive correlation between engagement and performance, suggesting that greater engagement increases the likelihood of students achieving their academic and personal goals.

In this study, engagement is defined as

> the energy and effort that students employ within their learning community, observable via any number of behavioral, cognitive or affective indicators across a continuum. It is shaped by a range of structural and internal influences, including the complex interplay of relationships, learning activities and the learning environment. (Bond et al., 2020, p. 3)

Fredricks et al. (2004) describe engagement as comprising three interrelated dimensions: behavioral, affective, and cognitive. Behavioral engagement thus relates to participation and effort, reflecting students' involvement in learning activities (Fredricks et al., 2004). Affective engagement is linked to students' relationships within their educational environment, including with peers and teachers. This dimension of engagement encompasses students' expectations, motivations, and assumptions about their learning (Redmond et al., 2018) and is associated with elements impacting motivation, such as a sense of belonging and specific emotional states (Abdool et al., 2017; Ali et al., 2020; Mulrooney & Kelly, 2020). Cognitive engagement pertains to the effort students exert to understand complex concepts and ideas, including reflecting on their own learning (Fredricks et al., 2004, 2016).

To optimize the use of educational technologies for enhancing the positive correlation between student engagement and learning outcomes, Chi and Wylie (2014) introduced a four-level taxonomy of engagement (interactive, constructive, active, and passive) applicable to online education. Each level corresponds to a set of underlying processes for the active construction of knowledge.

Passive engagement is characterized by the simple reception of information, where students do not engage in additional actions such as note-taking or asking questions. In contrast, active engagement implies physical interaction with or manipulation of information, demonstrating greater student involvement. Constructive engagement occurs when deeper cognitive processing leads students to generate new knowledge or products, such as explaining concepts in their own words, creating visual representations, or formulating questions for deeper exploration. Finally, interactive engagement occurs when two or more students engage in dialogue and collaboration, jointly constructing new ideas and enriching the learning process through the exchange of perspectives.

Chi and Wylie (2014) engagement levels are highly important as guides for instructional design and for establishing optimal control conditions in experimental studies. Furthermore, at each of these levels, increasing the integration of technological tools can enhance the depth of learning.

In this regard, Puentedura (2014) proposes a model to categorize the degree of this integration into four levels: substitution, augmentation, modification, and redefinition. Technology integration that does not produce a functional change in the learning activity is considered substitution. If the learning activity remains the same, technological integration that provides a functional improvement is considered augmentation. Conversely, technology integration that involves redesigning the learning activity is considered modification. Finally, integration leading to the creation of innovative activities is considered redefinition.

The interrelation between the models of Chi and Wylie (2014) and Puentedura (2014) highlights the wide range of technological combinations that can deepen learning while maintaining student engagement. Thus, the versatility and variety of H5P's interactive components establish it as a key tool for implementing innovative pedagogical strategies in education.

Bond et al. (2020), in contrast, conducted a comprehensive study of the instruments used to explore the impact of educational technology on student engagement. Consequently, a set of criteria was identified for evaluating this engagement based on its three dimensions (Table 1).

Table 1

Criteria to evaluate student engagement

Dimension	Criteria	Description
Cognitive	Deep Learning, Self-Regulation	Encompasses thinking, comprehension, and self-regulation of learning.
Affective	Interest, Motivation, Enthusiasm, Positive Attitude Towards Learning, Enjoyment	Relates to emotions, attitudes, and feelings concerning learning.
Behavioral	Participation/Interaction/Involvement, Achievement, Positive Interaction with Professors and Peers, Peer Learning	Involves the student's observable actions and behaviors.

Source: self-elaboration based on Bond et al. (2020).

Deep learning transcends rote memorization, entailing a meaningful comprehension of concepts (Finn & Zimmer, 2012). Self-regulation involves students demonstrating the capacity to reflect on the activities and strategies employed in their learning (Cleary & Zimmerman, 2012). These criteria are mutually reinforcing; their manifestation in students indicates the level of cognitive engagement.

Conversely, affective engagement manifests through interrelated emotions and attitudes, including interest, defined as the curiosity and relevance attributed to a task. It also encompasses intrinsic motivation, driving action from genuine desire; enthusiasm, expressed as joy and excitement; a positive attitude towards learning, based on self-efficacy; and enjoyment, reflecting satisfaction and pleasure derived from the activity, thereby consolidating the emotional bond with learning (Brookfield, 2009; Reeve, 2012; Skinner & Pitzer, 2012).

Behavioral engagement is evidenced by regular class participation, completion of activities, and student interaction with learning materials. The quality of assignments, persistence to overcome obstacles, and achievement of academic goals are indicators of behavioral engagement. Furthermore, behavioral engagement is also demonstrated by the initiative to seek clarification on doubts, respect for peers and class norms, willingness to participate in collaborative work, and the exchange of ideas and perspectives with peers to enhance learning (Martin & Borup, 2022; Pekrun & Linnenbrink-Garcia, 2012).

Several studies (Jacob & Centofanti, 2024; Rossetti-López et al., 2023; Sharmin et al., 2024) analyze students' perception of the use of interactive activities created with H5P in Moodle, finding a positive evaluation of these resources, especially in terms of facilitating learning and maintaining attention. For its part, the study by Jacob and Centofanti (2024) aimed to evaluate whether the implementation of learning activities, enriched with H5P interactive components, could improve learning outcomes in undergraduate students, but could not provide evidence of improvement in student performance attributable to these. Also, Sinnayah et al. (2021) conducted research aimed at exploring the use of H5P as a platform to foster self-directed learning in physiology students, finding a high level of engagement with learning. In addition, most students stated that their knowledge improved thanks to repeated practice, facilitated by H5P functionalities.

The studies analyzed, with the exception of Jacob and Centofanti (2024), use non-experimental methodologies, making it difficult to clearly and directly relate the findings to the various pedagogical implementations that use H5P to enrich the learning experience. Furthermore, literature lacks sufficient experimental studies establishing a direct relationship between the integration of H5P in the learning process and an improvement in student engagement. This study evaluates how H5P-designed activities influence university students' engagement in hybrid courses. The study was conducted in two Ecuadorian universities with mainly face-to-face study programs, although with some hybrid subjects that lacked interactive H5P activities. To guide the research, the following hypothesis was proposed: students who take part in H5P-based interactive activities, integrated into an innovative pedagogical methodology and enriched with audiovisual media, demonstrate greater engagement with their learning compared to those who do not participate in such activities.

METHODOLOGY

Research design

This study employed a mixed-methods, longitudinal, quasi-experimental design with intact groups. This design allowed the study to be conducted in contexts where groups were pre-existing and random assignment was not feasible. A mixed-methods approach was chosen to integrate both quantitative and qualitative data for evaluating the intervention's impact. A pretest-posttest design was employed to compare student engagement levels prior to and following the implementation of H5P activities across control and experimental groups.

Considering the complexity of the longitudinal research design, two professors from each university were selected, each managing two groups from the second and third year, teaching their respective subjects in a hybrid modality with a weekly one-hour session. This facilitated the study's feasibility and adherence to the schedule by ensuring effective coordination, streamlined data collection, and consistent participant monitoring. Furthermore, the similarity in the average age of the students facilitated adequate control, as they presented similar characteristics regarding cognitive maturity and academic experiences. It was also considered that both professors possessed comparable levels of experience in developing interactive activities with H5P and in the teaching-learning process mediated by educational technologies, aiming to minimize the impact of teacher-related variables.

Participants

The sample consisted of 87 university students, 76% of whom were female. Participants were enrolled at two universities in Portoviejo, Manabí: the Pontifical Catholic University of Ecuador, Manabí Campus (PUCESM), and the Technical

University of Manabí (UTM). Specifically, 40 second-year students from the Law and International Business programs at PUCESM were included (mean age = 19.4 ± 0.51 years), and 47 third-year Electrical Engineering students from UTM (mean age = 20.5 ± 0.7 years).

Instruments

To assess student engagement, a 12-item questionnaire was developed, drawing upon the theoretical construct of engagement proposed by Fredricks et al. (2004) and further elaborated by Fredricks et al. (2016), as well as the indicators suggested by Bond and Bedenlier (2019) to measure the cognitive, affective, and behavioral dimensions of engagement. The questionnaire comprised four items for each dimension of engagement: cognitive, affective, and behavioral. Each item presented a statement that participants rated using a 5-point Likert scale.

To measure the cognitive dimension, the questionnaire included the following items:

- I clearly understand the concepts explained in this course (CE1).
- I am able to apply what I learn in new situations (CE2).
- The activities I do allow me to deepen my knowledge (CE3).
- I feel confident when answering questions about the content (CE4).

For the affective dimension:

- I enjoy participating in the activities of this course (AE1).
- I feel motivated to learn the content (AE2).
- I believe that the topics covered are relevant to me (AE3).
- I am interested in learning more about this content (AE4).

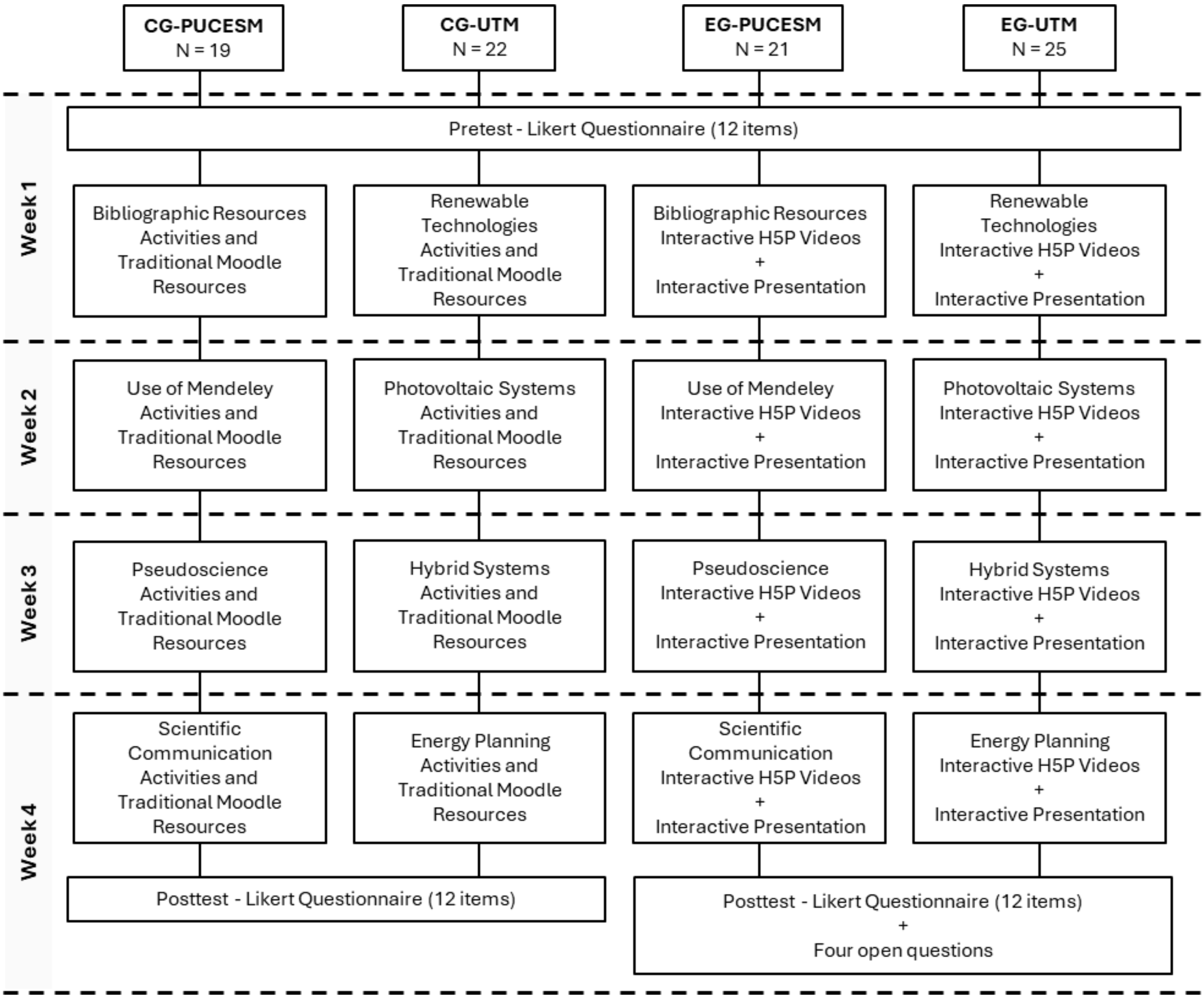
And for the behavioral dimension:

- I actively participate in classes and activities (BE1).
- I dedicate time to studying outside of class (BE2).
- I collaborate with my classmates on assignments (BE3).
- I seek opportunities to learn more on my own (BE4).

Procedure

The study included four student groups: two from PUCESM (enrolled in Research Fundamentals) and two from UTM (enrolled in Renewable Energy Sources). Each group was taught in a hybrid modality through the Moodle platform. In each university, one group was randomly assigned as the control group (CG) and the other as the experimental group (EG). In total, 46 students participated in the experimental groups and 41 in the control groups. At the beginning of the study, the 12-item questionnaire was administered to all participants to assess their initial level of engagement in the cognitive, affective, and behavioral dimensions (Figure 1).

Figure 1
Experimental procedure to evaluate the impact of H5P activities on student engagement



For four weeks, the experimental groups participated in a teaching-learning process based on the intensive use of interactive digital resources developed with H5P. Each week, a learning module was implemented in Moodle that included several interactive videos and presentations developed with H5P to cover the objectives of the class topic (Figure 1). Although the study's duration ensured its feasibility, it is acknowledged that this timeframe was limited and potentially insufficient to observe long-term effects on student engagement.

To ensure methodological consistency across the interventions within the experimental groups, the following strategy was implemented: the theoretical aspects of each of the four topics were addressed using microlearning modules featuring interactive H5P videos, each incorporating at least three interactive activities. Furthermore, aspects related to the application of the theory were addressed via at least one interactive presentation focused on problem-solving. The control groups, on the other hand, engaged in traditional activities within Moodle, designed to be equivalent in content and duration to those undertaken by the experimental groups, but without the integration of H5P.

Following the intervention, the questionnaire was administered, enhanced with four open-ended questions, to evaluate changes in the level of engagement. The first three questions were designed to obtain qualitative information from each dimension of engagement, and the last to obtain general information about the course up to the time of the intervention:

- What type of activities do you think have helped you to better consolidate the knowledge acquired in these weeks?
- What aspects of the activities carried out in class have sparked your curiosity and motivated you to investigate further the topics covered?
- How do you believe the activities we have carried out in class have contributed to your collaborative learning and your active participation in the course?
- Is there anything else you would like to share about your experience on this course?

Data analysis

Data analysis was conducted using SPSS version 25 and R (version 4.4.3). The reliability of the instrument was assessed using Cronbach's alpha, and its content validity was evaluated using Aiken's V, with the input of eight experts. Normality was tested using the Shapiro-Wilk test. In the descriptive analysis, the median and interquartile range (IQR) were calculated for each item at both pretest and posttest. The effect of the intervention was evaluated by comparing pretest and posttest scores using the Wilcoxon signed-rank test (wilcox.test() function in R). The pretest and posttest medians, the Z statistic, the two-tailed p-value, and the sums of positive (R+) and negative (R-) ranks will be reported in the Results section. The effect size (r) was calculated as $r = Z/\sqrt{N}$, where N is the number of pairs. Given that the difference was calculated as (pretest – posttest), a negative value of r indicates that, on average, posttest scores were higher than pretest scores. The magnitude of the effect was interpreted as: negligible ($|r| < 0.1$), small ($0.1 \leq |r| < 0.3$), moderate ($0.3 \leq |r| < 0.5$), or large ($|r| \geq 0.5$).

RESULTS

Descriptive statistics

Aiken's V was employed to assess content validity, yielding an overall value of 0.92. Cronbach's alpha was used to assess the questionnaire's reliability, revealing values ranging from 0.70 to 0.83 (Table 2).

Table 2

Statistical description of student engagement before and after intervention

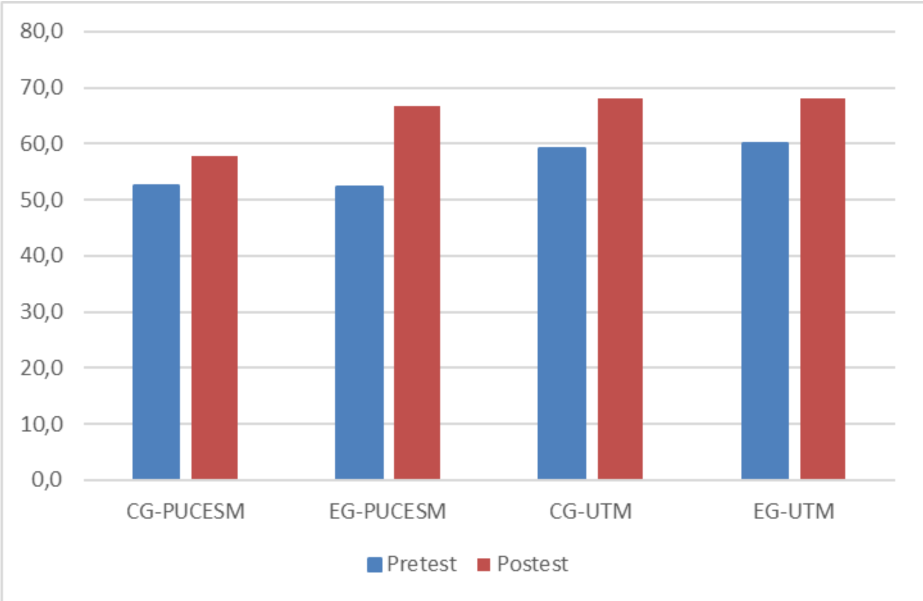
Group	Time	Measured Statistic	Criteria to evaluate student engagement											
			Cognitive				Affective				Behavioral			
			CE1	CE2	CE3	CE4	AE1	AE2	AE3	AE4	BE1	BE2	BE3	BE4
Control PUCESM N = 19	Pretest (0,79[a])	Median	4	4	4	4	4	4	4	4	4	4	4	4
		IQR	1,0	1,0	2,0	0,5	1,5	1,0	1,5	1,0	0,0	1,5	2,0	2,0
		Cronbach's Alpha	0,68				0,72				0,79			
	Posttest (0,81[a])	Median	4	4	4	4	4	4	4	4	3	4	4	5
		IQR	1,0	2,0	1,5	1,0	1,0	1,5	1,0	1,5	1,5	2,0	1,0	1,0
		Cronbach's Alpha	0,81				0,72				0,69			
Experimental PUCESM N = 21	Pretest (0,86[a])	Median	4	4	4	4	4	4	4	4	4	4	4	4
		IQR	1,0	1,0	1,0	1,0	1,0	1,0	1,0	2,0	1,0	1,0	1,0	2,0
		Cronbach's Alpha	0,76				0,74				0,73			
	Posttest (0,74[a])	Median	4	5	5	5	5	4	4	4	4	4	5	5
		IQR	1,0	1,0	1,0	1,0	1,0	1,0	1,0	2,0	1,0	1,0	1,0	1,0
		Cronbach's Alpha	0,69				0,75				0,75			
Control UTM N = 22	Pretest (0,76[a])	Median	4	4	4	4	4	4	3,5	4	4	4	4	4
		IQR	2,0	2,0	1,0	1,0	1,75	1,0	2,0	1,0	1,75	1,0	0,0	2,0
		Cronbach's Alpha	0,73				0,71				0,72			
	Posttest (0,78[a])	Median	4	4,5	4	4	4	4	4	4	4	4	4	4
		IQR	1,0	1,0	1,5	1,0	1,0	1,0	1,5	1,75	1,0	1,0	1,75	1,0
		Cronbach's Alpha	0,74				0,70				0,74			
Experimental UTM N = 25	Pretest (0,73[a])	Median	4	4	4	4	4	4	4	4	4	4	5	4
		IQR	1,0	2,0	1,0	1,0	1,0	2,0	1,0	1,0	1,0	2,0	1,0	1,0
		Cronbach's Alpha	0,75				0,78				0,71			
	Posttest (0,70[a])	Median	4	5	5	4	5	4	4	4	5	4	5	4
		IQR	1,0	1,0	1,0	1,0	1,0	2,0	1,0	1,0	1,0	1,0	1,0	1,0
		Cronbach's Alpha	0,74				0,74				0,74			

Note: [a] Cronbach's Alpha Coefficient calculated for all questionnaire items.

The descriptive analysis results indicate a high level of student participation in both administrations of the questionnaire (pretest and posttest). A comparison of pretest and posttest results shows an increase in the number of students expressing agreement or strong agreement with the questionnaire items across all groups (Figure 2).

Figure 2

Percentage of agreement between experimental and control groups in the application of the questionnaire



Note: the figure displays the minimum percentage value for each group.

Inferential statistics

An inferential analysis was conducted, comparing the scores obtained in the pretest and posttest for each item in the questionnaire in both the control and experimental groups. The Shapiro-Wilk test indicated that the data did not follow a normal distribution; therefore, the Wilcoxon signed-rank test for related samples was employed. Furthermore, the effect size was calculated to quantify the magnitude of the observed differences and to determine their practical significance. The results of these tests are presented in Table 3.

The responses to the four open-ended questions included in the posttest questionnaire for the experimental groups indicated that 96% of the students answered the first question. Many highlighted the value of activities that facilitated the practical application of knowledge and provided immediate feedback. Ninety-three percent of students responded to the second question; several expressed that the personalization and interactivity of the content were key factors in fostering their curiosity and motivation, and some suggested the inclusion of more exercises involving real-world scenarios. Regarding the third question, 87% of students responded, identifying the need for more teamwork-promoting activities. Finally, respondents to the fourth question offered various suggestions for enhancing the learning experience, such as increasing synchronous interaction with instructors, personalizing the process, and addressing technical issues.

Table 3

Pre-Post inferential analysis of student engagement in control and experimental groups using the Wilcoxon test and effect size (Rosenthal's r)

Criteria to evaluate student engagement		**Group**															
		Control PUCESM (N = 19)				**Experimental PUCESM (N = 21)**				**Control UTM (N = 22)**				**Experimental UTM (N = 25)**			
		Z	**R-/R+[a]**	**p-value**	**r**	**Z**	**R-/R+[a]**	**p- value**	**r**	**Z**	**R-/R+[a]**	**p- value**	**r**	**Z**	**R-/R+[a]**	**p- value**	**r**
Cognitive	CE1	-1,508	60 130	0,132	-0,35	-2,132	55,5 175,5	0,033	-0,47	-0,755	103,5 149,5	0,450	-0,16	-2,257	78,0 247,0	0,024	-0,45
	CE2	-0,984	72,5 117,5	0,325	-0,23	-2,034	57,5 173,5	0,042	-0,44	-1,127	97,5 155,5	0,260	-0,24	-2,173	90,5 234,5	0,030	-0,43
	CE3	-1,195	66,5 123,5	0,232	-0,27	-2,132	48,0 183,0	0,033	-0,47	-0,943	94,0 159,0	0,346	-0,20	-2,985	54,5 270,5	0,003	-0,60
	CE4	-1,027	76,5 113,5	0,305	-0,24	-1,964	59,0 172,0	0,049	-0,43	-1,069	99,0 154,0	0,285	-0,23	-1,668	108,5 216,5	0,095	-0,33
Affective	AE1	-0,595	84,5 105,5	0,552	-0,14	-1,999	64,0 167,0	0,046	-0,44	-0,883	92,0 161,0	0,377	-0,19	-2,812	62,5 262,5	0,005	-0,56
	AE2	-0,358	94,5 95,5	0,720	-0,08	-2,138	58,5 172,5	0,033	-0,47	-1,469	95,0 158,0	0,142	-0,31	-1,578	99,5 225,5	0,115	-0,32
	AE3	-1,209	65 125	0,227	-0,28	-1,186	95,0 136,0	0,236	-0,26	-1,160	104,5 148,5	0,246	-0,25	-1,325	116,0 209,0	0,185	-0,26
	AE4	-1,374	64 126	0,169	-0,32	-0,966	95,0 136,0	0,334	-0,21	-0,614	105,5 147,5	0,539	-0,13	-1,983	83,0 242,0	0,047	-0,40
Behavioral	BE1	-1,109	124 66	0,268	-0,25	-1,277	83,5 147,5	0,202	-0,28	-0,790	103,0 150,0	0,429	-0,17	-2,231	84,5 240,5	0,026	-0,45
	BE2	-0,247	98 92	0,805	-0,06	-1,633	72,5 158,5	0,102	-0,36	-0,714	94,0 159,0	0,475	-0,15	-1,978	95,5 229,5	0,048	-0,40
	BE3	-0,966	76,5 113,5	0,334	-0,22	-1,355	81,5 149,5	0,175	-0,30	-0,885	105,0 148,0	0,376	-0,19	-1,069	125,5 199,5	0,285	-0,21
	BE4	-0,964	60,5 129,5	0,335	-0,22	-2,183	61,5 169,5	0,029	-0,48	-0,741	104,0 149,0	0,458	-0,16	-1,210	122,0 203,0	0,226	-0,24

Note: [a] In each cell: R- = sum of negative ranks; R+ = sum of positive ranks (Wilcoxon test).

DISCUSSION

The differences observed between the pretest and posttest measurements for the cognitive dimension in both control groups did not reach statistical significance. Furthermore, the effect sizes, all below 0.5, suggest that the observed changes in scores were of low magnitude. This suggests that while there were some variations in the distribution of ranks, these were not sufficiently consistent to be considered statistically significant.

Regarding the affective dimension, the p-values for both control groups did not reveal significant differences, and the effect sizes were small. This suggests that perceptions of motivation, interest, and course relevance remained relatively stable between the pretest and posttest. Similarly, in the behavioral dimension, the differences were not significant, and the effect sizes were small in both groups. These results reflect the relative stability of the perceptions and behaviors measured in both control groups, which was expected due to the absence of any interventions designed to promote substantial changes in the evaluated dimensions.

Conversely, in the cognitive dimension, the intervention demonstrated a positive impact in both experimental groups, although the significance and magnitude of the effect varied across the items. Regarding the understanding of the concepts explained in the course (CE1), both experimental groups exhibited statistically significant improvements, even though the median (4) and the IQR (1.0) remained constant between the pretest and posttest.

Regarding the ability to apply knowledge to new situations (CE2), both experimental groups demonstrated significant improvements, with the median increasing from 4 to 5. However, while the IQR remained at 1.0 in PUCESM, it decreased from 2.0 to 1.0 in UTM, indicating not only an improvement in perceived ability but also a greater homogeneity in the responses following the intervention.

The perception of deepened knowledge through activities (CE3) significantly improved in both groups, with the median increasing from 4 to 5 in both instances. The effect size in UTM, $r = -0.60$, suggests a substantial practical impact of the intervention on UTM students' perception of this item. Finally, in relation to confidence in answering questions (CE4), only the PUCESM group showed a statistically significant improvement, with an increase in the median (from 4 to 5). Although in UTM the median of CE4 also increased, the change was not significant.

The analysis of the affective dimension in the experimental groups presents a nuanced picture. Both experimental groups showed statistically significant improvements in the enjoyment of course activities (AE1). However, the impact of the intervention was more pronounced in EG UTM ($r = -0.56$, $p = 0.005$) compared to EG PUCESM ($r = -0.44$, $p = 0.046$). This suggests that the intervention, as implemented in the UTM, was particularly successful in generating a more pleasant learning experience for students.

Regarding motivation to learn the content (AE2), the experimental group at PUCESM showed a significant improvement ($r = -0.47$, $p = 0.033$). This suggests a greater effectiveness of the intervention at PUCESM in promoting students' intrinsic motivation, in contrast to UTM, where no significant change was observed.

While perceived relevance (AE3) did not change significantly in any of the groups, interest in learning more (AE4) increased significantly in UTM ($r = -0.40$, $p = 0.047$), with a moderate effect size. Despite this lack of change in perceived relevance, the significant increase in interest in learning more in the EG UTM suggests that the intervention likely sparked curiosity and highlighted the potential long-term value of the content.

The lack of a significant improvement in perceived relevance (AE3) in both experimental groups might be attributed to pre-existing factors, such as students' initial perceptions of the subjects and the alignment between the curriculum and their individual interests. These factors could have shaped students' perceptions of course relevance, regardless of the intervention (Sailer et al., 2024). Furthermore, the lack of improvement in AE3 might also be related to the high value students placed on instructor support and personalized learning, as evidenced in their responses. For instance, one student stated, 'It would be beneficial if the instructor dedicated more time, either in person or online, to answering questions and resolving doubts,' while another noted, 'I believe more live sessions should be conducted to allow for direct questioning regarding areas of difficulty'.

Considering the above, the consistency of synchronous instructor presence and support, combined with students' experience in online learning, may have influenced the optimal use of the synergistic impact between interpersonal ties (student-teacher relationships) and intrapersonal ties (motivation, self-efficacy) on the affective component of student engagement (Martin et al., 2017; Redmond et al., 2018). This suggests the need to explore strategies that involve, for example, the integration of H5P activities and forums to foster discussion and exchange of ideas among all participants.

Finally, regarding the behavioral dimension, the results varied between the experimental groups. Concerning active participation in classes and activities (BE1), no improvement attributable to the intervention was observed in EG PUCESM. In contrast, EG UTM exhibited a statistically significant improvement ($r = -0.45$, $p = 0.026$), as evidenced by the increase in the median from 4 to 5. This suggests greater student involvement and active participation resulting from the intervention. Regarding time spent studying outside of class (BE2), neither experimental group showed significant improvements. This could be due to the difficulty of altering established study habits, the academic workload, and limitations in technological infrastructure, which likely reduced the effectiveness of H5P activities.

Regarding collaboration with peers on tasks (BE3), no statistically significant changes were observed in either group after the intervention. These findings suggest that the intervention did not consistently encourage peer collaboration, potentially due to the short duration of the intervention and individual preferences for independent work. Concerning the search for opportunities to learn more independently (BE4), EG PUCESM not only recorded a statistically significant increase in the median (from 4 to 5, $p = 0.029$) but also a decrease in the IQR (from 2 to 1), indicating greater homogeneity in responses and a more consistent positive effect of the intervention within this group. In contrast, EG UTM showed no significant changes. This difference could be attributed to the intrinsic nature of motivation for autonomous learning, which may be more challenging to influence through specific interventions, especially if students already possess baseline levels of autonomy (Bakker et al., 2015; Safarifard et al., 2024).

Finally, it is worth noting that the evaluation of this dimension was based on self-reporting. While the instrument was grounded in a strong theoretical framework with consensus among experts, this reliance on self-reporting might have influenced the accuracy of the estimates of collaboration and autonomous learning.

In general, the findings of the study support cognitive and sociocultural learning theories (Kang & Furtak, 2021; Ortiz & Corrêa, 2020; Safarifard et al., 2024) and align with the argument by Bakker et al. (2015) that learning environments enriched with resources and opportunities for growth foster greater engagement, which in turn predicts positive academic performance. Moreover, these results support the constructivist perspective that interactive activities using H5P can promote deeper and more meaningful learning by allowing students to build their own knowledge through exploration and experimentation, which in turn enhances cognitive engagement (Murillo Sevillano et al., 2023).

According to Puentedura (2014), integrating H5P into activity design can be classified as 'Modification', as it involves redesigning traditional tasks, which fosters greater student interaction and engagement. Consistent with Chi and Wylie (2014), the results suggest that the activities employing interactive videos and presentations created with H5P facilitated a transition to deeper levels of cognitive engagement. Finally, these results suggest new directions for research, particularly focusing on the long-term impact of instructional designs that extensively utilize H5P, as well as the exploration of synergistic combinations of H5P with a broader range of digital educational resources.

CONCLUSIONS

This study, focused on evaluating the impact of H5P-based activities on student engagement in hybrid courses at two Ecuadorian universities, found mixed results depending on the specific dimension of engagement. While the intervention demonstrated a positive effect on key cognitive aspects such as concept comprehension, knowledge application, perceived depth of learning, and enjoyment of activities (affective dimension), no significant improvements were observed in the perceived relevance of the content (affective dimension) or in collaboration among peers (behavioral dimension). Therefore, while H5P can be a useful component in the design of learning experiences, its integration must be strategic and complemented with other pedagogical approaches, especially if the goal is to foster collaborative work and connect the content to students' interests. These findings are particularly relevant to the developing field of research on the impact of these tools on student engagement within the Latin American context.

In this regard, instructional designs that strategically integrate H5P with other pedagogical approaches are proposed. One option would be to design complex scenarios in H5P that require collaborative problem-solving, where students work in teams to discuss and reach consensus. Another possibility is implementing a cooperative learning methodology that uses H5P modules for small groups to specialize in different content, thus fostering interdependence and knowledge exchange. Additionally, interactive H5P content could be used as a starting point for structured debates, in forums or in synchronous sessions, to connect the material to meaningful discussions and enhance its perceived relevance. Finally, another alternative is to involve students in the co-creation of H5P activities, which could promote collaboration and a deeper understanding of the content.

The main limitations of this study are its quasi-experimental design, which hinders establishing definitive causal relationships; the lack of control over variables such as prior performance and familiarity with technology; and the relatively short duration of the intervention. For future research, it is recommended to adopt more rigorous methodological designs, such as experimental studies with random assignment or quasi-experimental designs with more equivalent control groups, which allow for a more certain establishment of the causal relationship between the interventions and changes in student engagement. It is crucial to expand the sample size to improve statistical power and the generalization of results, as well as to use a multidimensional approach in the measurement of engagement, combining questionnaires with observations, learning data analysis, and qualitative interviews for a more complete understanding. Studies should be extended over time, with longitudinal designs, to evaluate the sustainability of effects. Furthermore, it is essential to investigate the impact of different instructional designs that integrate technology, keeping H5P as a central component, while comparing various pedagogical approaches to identify the most effective strategies in promoting the different dimensions of student engagement. Finally, the geographical and cultural context of these investigations should be expanded.

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