

IMPACT OF THE “IALAB MAKERS” EDUCATIONAL INNOVATION
PROJECT (FORMERLY PRACTICS UNIZAR) ON UNIVERSITY STUDENTSReina Castellanos-Vega , Pablo Usán-Supervía* , Julia Sánchez-García 

Universidad de Zaragoza (Spain)

rvega@unizar.es*Corresponding author: pusan@unizar.esjuliasanchezg@unizar.es

Received December 2024

Accepted July 2026

Abstract

Innovation in higher education is closely linked to digital transformation and information systems. This connection has unlocked numerous possibilities following the implementation of the Bologna Process in university classrooms. Such a scenario demands an evaluation that facilitates improvements in both knowledge acquisition and students' holistic personal development. The study evaluated a sample of 102 prospective primary education teachers ($M = 18.58$; $SD = 0.84$), consisting of female ($n = 70$; 68.62%) and male ($n = 32$; 31.37%) participants. Data were collected using various assessment instruments designed to evaluate motivation, group integration and digital expertise. The analysis revealed significant gender differences, alongside a notable increase across all three evaluated variables. Furthermore, high intrinsic motivation was positively associated with greater group integration, higher digital expertise and adaptive behavioural patterns. The findings demonstrate the positive impact of the evaluated project on motivation, group integration and digital expertise. They also highlight the effectiveness of innovative programmes focused on creating teaching materials through Information and Communication Technology (ICT) resources, thereby equipping prospective teachers with the digital competence required for their future professional practice.

Keywords – Innovation, Project, Motivation, Group cohesion, Digital competence.**To cite this article:**

Castellanos-Vega, R., Usán-Supervía, P., & Sánchez-García, J. (2026). Impact of the “IALAB MAKERS” educational innovation project (formerly PracTICS UNIZAR) on university students. *Journal of Technology and Science Education*, 16(2), 576–591. <https://doi.org/10.3926/jotse.3261>

1. Introduction

Teaching plays a fundamental role in student's education, carrying significant implications for their overall development. Excellent teaching practices and constructive teaching staff-student interactions can make a meaningful difference in the educational process, offering both personal and academic benefits for students (Antepara, 2022). Throughout their higher education journey, students navigate diverse academic and contextual situations where effective teaching can channel their motivation and engagement towards

academic tasks. By acting as facilitators of knowledge and instructional guides, educators help personalise learning while building a positive and enriching environment (Varela, 2023).

In recent years, the implementation of the Bologna Process of 1999 in higher education has driven the incorporation of numerous projects, programmes and technological tools across various instruments, spurring a methodological transformation in educational practice (Usán & Salavera, 2020). Consequently, educational advancement is essential for adapting to a rapidly evolving society and preparing students to address the challenges and opportunities of the 21st century (Velasco, 2023).

In this context, adopting innovative programmes within university settings is paramount. These initiatives contribute significantly to bridging digital learning divides among students, thereby ensuring educational equity. Furthermore, these programmes promote inclusion and equality, strengthen socio-emotional skills, foster autonomy and self-regulation and boost overall academic performance (Torrico et al., 2022).

Likewise, during their university years, students encounter diverse personal and contextual experiences rooted in their interpersonal relationships with peers, teaching staff and other members of the academic community. Navigating these interactions supports holistic personal growth, drawing upon interrelated psychological variables that consolidate their personality throughout youth and adulthood (Coelho & Menezes, 2021).

1.1. Academic Motivation

Academic motivation is one of the most widely studied variables in higher education research. It represents a cornerstone of student life, significantly influencing academic performance, enthusiasm for learning and overall educational success (Pegalajar-Palomino, 2020). The concept refers to the underlying set of reasons, goals and desires that drive students to engage academically, strive towards educational objectives and persevere despite encountering obstacles (Morales, 2021). Its essential value lies in its function as an internal impetus that prompts students to seek knowledge, participate in class, complete assignments and pursue continuous self-improvement. When students are academically motivated, they demonstrate a heightened interest in learning, which fosters more effective and durable knowledge retention (Hendrie & Bastacini, 2020). However, academic motivation is neither infinite nor static; it fluctuates based on variables such as course difficulty, relationships with the teaching staff, exam pressure and personal or professional ambitions. Understanding its underlying dynamics and actively nurturing it within higher education classrooms is, therefore, essential (Lion & Maggio, 2019).

Self-Determination Theory (SDT) addresses individual volition, proposing that decision-making is guided by personal values, goals and three innate psychological needs: autonomy, competence and relatedness (Deci & Ryan, 2002). Motivation plays a central role in this framework, which distinguishes between intrinsic motivation (driven by inherent personal satisfaction), extrinsic motivation (directed towards external outcomes or rewards) and amotivation (the absence of personal drive to perform a given task or action).

Existing literature links optimal academic motivation to increased academic effort (Nieto et al., 2021), higher task engagement (Cobo-Rendón et al., 2022), greater self-efficacy during task execution (Trujillo & Bermúdez, 2020), adequate emotional intelligence levels (Salvador, 2021), enhanced overall academic well-being (Vitai & Benke, 2021) and reduced university dropout rates (Tomás & Gutiérrez, 2019).

Consequently, academic motivation is a crucial driver of student engagement and commitment to university coursework, fostering an active mindset and a willingness to meet academic demands (Sánchez, 2021).

1.2. Group Cohesion

Another key variable within university student group processes is team cohesion—an aspect that has gained heightened prominence since the implementation of the Bologna Process of 1999 in the Spanish university system around 2012. Team cohesion strongly emphasises group-based learning competences. It refers to the strength, connection and mutual understanding among team members. When a team is

cohesive, its members collaborate effectively, demonstrate commitment to shared goals and support one another. Consequently, cohesion serves as a vital factor in achieving successful task outcomes, as it enhances information sharing, mutual aid and overall productivity (Paredes & Silva, 2022).

Originally applied within sports psychology, the concept of group cohesion subsequently expanded to organisational and educational contexts (Checa & Bohórquez, 2020; Torralbas & Cabrera, 2019). While initially viewed as a unidimensional construct, it is now understood as multidimensional, encompassing members' shared perceptions of group cohesion (group integration) as well as each member's personal ties to the group (interpersonal attraction). These dimensions address both task-oriented aspects—where the group joins forces to accomplish academic objectives—and social aspects aimed at maintaining and advancing interpersonal relationships within the team (Checa & Bohórquez, 2020).

Although empirical research on group cohesion within university teams remains relatively limited, existing studies point to an unequivocal link between higher academic motivation and elevated cohesion levels among group members (Rojas et al., 2019). Cohesion also correlates positively with other psychoeducational variables, including self-esteem (Quispe, 2020), social skills and leadership (Paredes & Silva, 2022), as well as greater academic engagement and academic happiness (Carhuajulca, 2021).

1.3. Digital Competence

The emergence of new technologies—particularly over the past decade—has significantly shaped contemporary society, which is defined by a multiplicity of media platforms, technological tools as well as varied languages and formats (Cabero et al., 2020).

Within this context, and in accordance with Spain's organic education law (BOE, 2020), educators' digital competence “involves the safe, healthy, sustainable, critical and responsible use of digital technologies for learning, work, and societal participation, as well as interaction with them”. Consequently, per the Sectoral Conference on Education Agreement regarding the certification, accreditation and recognition of the Digital Competence Framework for Teachers, “a common six-level framework is established for teaching staff to describe the digital competences of any educator across the different stages of their professional development, regardless of the subject, grade level or educational track taught” (National Institute of Educational Technologies and Teacher Training, 2025, p. 1).

Against this backdrop, institutions across the educational and technological sectors have conducted research and implemented projects on integrating Information and Communication Technologies (ICT) into higher education, establishing skill-based training pathways for educators' digital competence (García et al., 2017; González & Dueñas, 2022; Leiva et al., 2022). In line with this approach, the innovative initiative “PracTICS” leverages digital tools to foster prospective teachers' digital competences while simultaneously integrating diverse active learning methodologies into classroom practice (Figure 1).

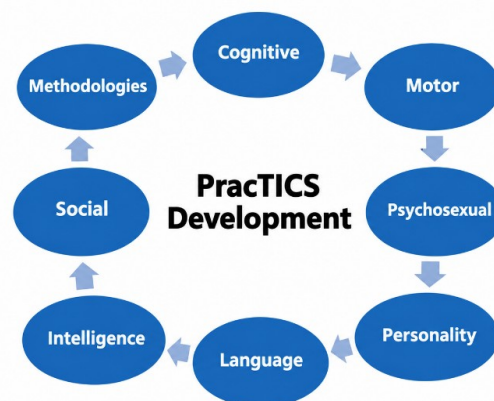


Figure 1. Contents of the “PracTICS” innovation programme

Overall, the implementation of educational intervention programmes is essential to ensure inclusive, high-quality education. They address student needs and promote academic success by enhancing key psychological variables involved in personal development, thereby contributing to a more equitable and cohesive educational community (Velasco, 2023).

1.4. Educational Innovation Project

The innovation project is grounded in a student-centred approach, where students take an active role in constructing their own knowledge. Specifically, the experience is structured around Cooperative Learning and Project-Based Learning (PBL) (Goodwing, 2024; Yolnasdi et al., 2025). The goal is for students to transition from mere consumers of digital resources to critical creators through the cooperative production of materials. This aligns with Bologna Process guidelines advocating for the acquisition of learning competences through group-based processes (Uysal, 2025; Zuhri & Afriani, 2025). This methodological framework ensures holistic training that extends beyond academics by integrating psychological, social and technological dimensions essential for the personal growth of 21st-century prospective teachers (Almazroa & Alotaibi, 2023). It was selected because pre-service teacher education requires not only a grasp of developmental stages, but also the ability to communicate and work with these core psychological and educational concepts using modern digital tools (Yañez-Sepulveda et al., 2024). These cooperatively created educational materials corresponded to each theoretical topic and were generated on a weekly or biweekly basis, sequentially connecting theory and practice.

Students enrolled in the Developmental Psychology course were organised into stable cooperative working groups. The dynamic began with a theoretical lecture at the start of the week presenting the scientific foundations of the topic (e.g., stages of cognitive development). Subsequently, during practical sessions, each group designed and prototyped a digital product aimed at solving a practical problem or serving as an instructional resource for that specific content. During material creation, students progressed through three phases: 1) analysis and debate: the group discussed how to translate theoretical concepts into a digital instructional format; 2) digital production: using selected tools (Table 1), students collaborated synchronously or asynchronously to generate the resource. For instance, in the cognitive development module, groups utilised applications like Edpuzzle or Powtoon to create interactive micro-learning modules on developmental stages; 3) evaluation and feedback: each product was submitted on a weekly or biweekly basis and evaluated using learning rubrics, enabling students to receive continuous feedback on their digital and pedagogical competences prior to final grading.

Finally, innovation was reinforced by the practical applicability of learning, as several productions were developed in collaboration with external educational institutions and centres, providing the activity with a real-world and professional context.

As detailed in Table 1, the selection of digital resources aligns with specific pedagogical objectives across each thematic module. Audiovisual and interactive creation tools (such as Edpuzzle, Powtoon or Flip) are used to help students synthesise and visually explain complex concepts, including the stages of cognitive development. Graphic design platforms (such as Canva or Genially) are utilised to develop professional teaching materials, while gamification tools (such as Kahoot!, Quizizz or Quizlet) facilitate formative assessment and peer feedback. Finally, content curation and organisation platforms (such as Padlet, Wakelet or Google Sites) enable students to structure the information gathered in each practical module both logically and collaboratively.

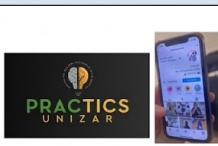
1. Cognitive 	2. Personality 	3. Language 
4. Intelligence 	PracTICS Educational Developments and Products	5. Socioemotional 
6. Physical-Motor 	7. Psychosexual 	8. Methodology 

Table 1. Contents of the “PracTICS” Innovation Programme

Accordingly, the primary objective of this study is to examine the effect of an educational innovation programme on three key variables: academic motivation, group cohesion and digital competence among university students. To this end, the following hypotheses were formulated:

- The “PracTICS” innovation programme will increase prospective teachers’ academic motivation, group cohesion and digital competence.
- There will be a positive correlation between students’ intrinsic motivation and their levels of group cohesion and teaching digital competence.
- Significant behavioural patterns will emerge, characterised by high levels of motivation, group cohesion and teaching digital competence.

2. Methodology

2.1. Sample

A total of 102 university students participated in the study, comprising female (68%) and male (31%) participants. Inclusion criteria required enrolment in Groups 3 and 4 (afternoon shift) and the ability to read and comprehend Spanish fluently to ensure satisfactory completion of the questionnaires. No exclusion criteria were applied, as no incomplete questionnaires were recorded and all students successfully understood and answered the items. The overall response rate was 100% (Table 2).

		N	%
Gender	Female	70	68.62
	Male	32	31.37
Age	18 years	58	56.86
	19 years	34	33.33
	20 years	6	5.88
	21 years	2	1.96
	22 years	2	1.96

Table 2. Student gender and age

2.2. Assessment Instruments

Participant data were collected through three questionnaires aligned with the study's objectives and hypotheses across two time points—pretest and posttest—administered before and after the intervention project.

First, academic motivation was evaluated using the Academic Motivation Scale (*Escala de Motivación Educativa*, EME; Núñez et al., 2010), comprising 28 items categorised into three main factors: intrinsic motivation, extrinsic motivation and amotivation. Responses were recorded on a 5-point Likert scale ranging from 1 (“Strongly disagree”) to 5 (“Strongly agree”). The original instrument demonstrated good internal consistency with a Cronbach's alpha of .80, yielding a value of .81 in the present study.

Second, group cohesion within the seminar groups participating in the project was measured using the Group Environment Questionnaire (GEQ; Leo et al., 2015). The scale evaluates four factors: Individual Attractions to Group-Task, Individual Attractions to Group-Social, Group Integration-Task and Group Integration-Social, reflecting task and social orientations across perceptions of attraction and integration. Items were scored on a 5-point Likert scale from 1 (“Strongly disagree”) to 5 (“Strongly agree”). The instrument reported an original Cronbach's alpha of .70 (Usán & Salavera, 2018), yielding a value of .75 in our study.

Third, university students' digital skills were assessed using the Digital Competence Questionnaire for Future Teachers (*Cuestionario de Competencia Digital para Futuros Maestros*, CCD; Cabero et al., 2020), which consists of 20 items distributed across five factors: technological literacy, communication and collaboration, information searching and processing, digital citizenship and creativity and innovation. Responses were structured on a 5-point Likert scale ranging from 1 (“Strongly disagree”) to 5 (“Strongly agree”). The original instrument demonstrated an original Cronbach's alpha of .93, whereas a value of .86 was obtained in the present study.

2.3. Procedure

Institutional authorisation was obtained from the selected faculty, alongside informed consent from all adult students prior to their participation. Data collection was conducted on a completely voluntary basis and in full compliance with the ethical principles of the Declaration of Helsinki (World Medical Association, 2000). Students were fully informed about the research purpose prior to data collection. Questionnaire administration for pretest and posttest measures took place during the first and last class sessions of the second semester, respectively, within students' regular classrooms using Google Forms.

The study protocol was approved by the OPIICS research group (S46_23R) from the Department of Psychology and Sociology at the University of Zaragoza. Participant anonymity was strictly guaranteed across all instruments; data were anonymised using alphanumeric codes to enable matching pretest and posttest responses across time points. Students joined the study voluntarily and retained the freedom to withdraw at any time without providing justification.

2.4. Data Analysis

First, descriptive statistics were computed to analyse sample sociodemographics (gender and age) and baseline values for academic motivation, group cohesion and future teachers' digital competence, examining potential gender differences. Bivariate correlation analyses were then conducted among all study variables using IBM SPSS Statistics (v. 29.0). Subsequently, paired-samples t-tests were performed to compare pretest and posttest mean scores to assess significant changes following the intervention. Finally, a cluster analysis was conducted to classify the sample into three meaningful subgroups to identify distinct behavioural patterns. All statistical analyses were conducted at a significance threshold of $p \leq .05$, corresponding to a 95% confidence interval.

3. Results

3.1. Descriptive Variables

Overall, prospective teachers displayed, on average, higher levels of (intrinsic) motivation and digital competence. The amotivation dimension yielded the lowest mean score (Table 3).

Overall, the research findings revealed notable disparities between female and male students regarding academic motivation, whilst group cohesion and digital competence displayed a more balanced profile across genders. First, female students reported higher scores on intrinsic motivation dimensions than male students, showing a small effect size for “intrinsic motivation – to know” ($d = .42$). Conversely, male students exhibited markedly higher levels of “extrinsic motivation – external regulation”, with a moderate effect size ($d = .66$). Amotivation levels were slightly higher among male students than female students. Second, group cohesion scores remained similar across both genders, although female participants presented marginally higher values for task-oriented individual attraction ($d = .12$) and task-oriented group integration ($d = .33$). Finally, university students of both genders demonstrated highly comparable profiles across all dimensions evaluating digital competence.

	Total		Female		Male		Cohen's d
	x	sd	x	sd	x	sd	
Academic motivation							
1. Intrinsic – to know	4.69	.48	4.76	.45	4.55	.54	.422
2. Intrinsic – towards accomplishment	4.72	.48	4.72	.55	4.71	.26	.023
3. Intrinsic – to experience stimulation	4.75	.36	4.80	.32	4.68	.44	.311
4. Extrinsic – external regulation	4.60	.76	4.25	.96	4.78	.60	-.662
5. Extrinsic – introjected regulation	4.49	.76	4.50	.88	4.51	.39	-.014
6. Extrinsic – identified regulation	4.67	.50	4.68	.54	4.66	.42	.041
7. Amotivation	1.31	.60	1.25	.48	1.38	.73	-.210
Group cohesion							
8. Individual attraction to group – Task	4.71	.51	4.75	.38	4.69	.57	.123
9. Individual attraction to group - Social	4.63	.53	4.62	.59	4.62	.36	.000
10. Group integration - Task	4.65	.49	4.69	.48	4.53	.50	.326
11. Group integration - Social	4.72	.55	4.71	.44	4.72	.60	-.019
Digital competence							
12. Technological literacy	4.88	.30	4.81	.19	4.83	.34	-.072
13. Communication and collaboration	4.71	.47	4.72	.49	4.68	.43	.086
14. Information searching and processing	4.80	.31	4.80	.34	4.83	.22	-.104
15. Digital citizenship	4.81	.34	4.82	.33	4.80	.36	.057
16. Creativity and innovation	4.78	.36	4.78	.37	4.76	.34	.056

Table 3. Descriptive variables and gender differences

3.2. Correlational Analysis between Academic Motivation, Group Cohesion and Digital Competence

The correlational analysis among the study variables is presented in Table 4. Notably, intrinsic motivation dimensions showed strong positive correlations with all group cohesion factors—particularly those oriented towards task objectives (individual attraction to group-task and group integration-task)—as well as with most dimensions of digital competence. Similarly, extrinsic motivation subscales correlated positively with group cohesion, reflecting the orthogonal nature of motivation across its intrinsic and extrinsic dimensions; however, extrinsic motivation displayed virtually no significant relationships with digital competence factors. Amotivation was significantly associated primarily with intrinsic motivation components.

Furthermore, several key findings emerged regarding the relationship between group cohesion and digital competence. Both task-oriented individual attraction and task-oriented group integration correlated significantly with most digital competence dimensions, following an adaptive functional pattern similar to that observed for intrinsic motivation. Conversely, social-oriented group integration demonstrated the weakest association with digital skills. Finally, amotivation was negatively associated with both group cohesion and digital competence variables, although these inverse relationships did not reach statistical significance.

3.3. Pretest and Posttest Analysis of Academic Motivation, Group Cohesion and Digital Competence

A paired-samples t-test comparing the mean scores across all dimensions of academic motivation, group cohesion and digital competence revealed statistically significant differences from pretest to posttest across every single dimension analysed (Table 5). These results demonstrate a significant post-intervention increase in students' academic motivation types, group cohesion, and digital competence following the implementation of the programme.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Intrinsic – to know	1														
2. Intrinsic – towards accomplishment	.564**	1													
3. Intrinsic – to experience stimulation	.710**	.393**	1												
4. Extrinsic – external regulation	.233*	.382**	.161	1											
5. Extrinsic – introjected	.434**	.486**	.331**	.247*	1										
6. Extrinsic – identified	.578**	.550**	.475**	.413**	.605**	1									
7. Amotivation	-.295**	.027	-.253*	-.128	-.010	-.384**	1								
8. Individual attraction to group - Task	.590**	.581**	.604**	.501**	.426**	.590**	-.074	1							
9. Individual attraction to group - Social	.485**	.510**	.555**	.393**	.367**	.458**	.074	.830**	1						
10. Group integration – Task	.533**	.578**	.501**	.340**	.457**	.544**	-.042	.684**	.541**	1					
11. Group integration – Social	.436**	.578**	.496**	.366**	.485**	.580**	-.042	.676**	.743**	.524**	1				
12. Technological literacy	.460**	.279**	.480**	.073	.249*	.154	-.046	.366**	.354**	.375**	.079	1			
13. Communication and collaboration	.228*	.137	.191	-.011	.042	.216*	-.094	.008	.111	.031	.181	.365**	1		
14. Information searching and processing	.308**	.327**	.255**	.159	.078	.202*	-.248*	.207*	.176	.175	.207*	.394**	.713**	1	
15. Digital citizenship	.397**	.406**	.336**	.208*	.149	.341**	-.188	.210*	.160	.354**	.115	.440**	.541**	.722**	1
16. Creativity and innovation	.318**	.299**	.422**	.072	.023	.140	-.003	.273**	.267**	.443**	-.018	.757**	.488**	.567**	.653**

Table 4. Correlational analysis between academic motivation, group cohesion and digital competence

	PRETEST		POSTTEST		Diff.	t	p	CI 95%
	x	sd	x	sd				
1. Intrinsic – to know	3.76	0.68	4.69	0.48	-0.92	-13.598	0.00	[-1.06 / -0.79]
2. Intrinsic – towards accomplishment	3.61	0.89	4.72	0.48	-1.11	-11.192	0.00	[-1.30 / -0.91]
3. Intrinsic – to experience stimulation	3.65	0.70	4.75	0.36	-1.10	-15.018	0.00	[-1.25 / -0.96]
4. Extrinsic – external regulation	3.71	0.83	4.60	0.76	-0.89	-9.691	0.00	[-1.07 / -0.70]
5. Extrinsic – introjected	3.04	1.03	4.49	0.76	-1.44	-13.522	0.00	[-1.65 / -1.23]
6. Extrinsic – identified	3.88	0.67	4.67	0.50	-0.79	-11.407	0.00	[-0.93 / -0.65]
7. Amotivation	2.20	1.20	1.31	0.60	0.88	7.480	0.00	[0.64 / 1.11]
8. Individual attraction to group - Task	3.92	0.68	4.71	0.51	-0.79	-12.625	0.00	[-0.91 / -0.66]
9. Individual attraction to group - Social	3.84	0.77	4.63	0.53	-0.78	-10.323	0.00	[-0.93 / -0.63]
10. Group integration - Task	3.74	0.87	4.65	0.49	-0.90	-9.879	0.00	[-1.09 / -0.72]
11. Group integration – Social	3.88	1.05	4.72	0.55	-0.84	-8.280	0.00	[-1.04 / -0.64]
12. Technological literacy	3.88	0.74	4.83	0.30	-0.94	-11.410	0.00	[-1.11 / -0.78]
13. Communication and collaboration	3.52	0.82	4.71	0.47	-1.19	-13.566	0.00	[-1.37 / -1.02]
14. Information searching and processing	3.92	0.72	4.80	0.31	-0.88	-12.234	0.00	[-1.02 / -0.73]
15. Digital citizenship	3.99	0.60	4.81	0.34	-0.82	-12.579	0.00	[-0.95 / -0.69]
16. Creativity and innovation	3.52	0.70	4.78	0.36	-1.25	-16.621	0.00	[-1.40 / -1.10]

Table 5. Pretest and posttest analysis of academic motivation, group cohesion, and digital competence

3.4. Cluster Analysis Into Meaningful Groups of Academic Motivation, Group Cohesion and Digital Competence

A K-means cluster analysis was conducted using the standardised scores of academic motivation, group cohesion and digital competence variables, classifying the study sample into three mutually distinct and meaningful groups (Table 6).

	Group 1 (N=8, 7.84%)		Group 2 (N=72, 70.58%)		Group 3 (N=22, 21.56%)		Total (N=102, 21.56%)		F	Sig.
	X	SD	X	SD	X	SD	X	SD		
1. Intrinsic – to know	4.50	1.20	4.92	0.27	4.18	-0.04	4.69	.48	45.399	.000
2. Intrinsic – towards accomplishment	3.00	-0.29	4.91	0.26	4.42	0.19	4.72	.48	45.185	.000
3. Intrinsic – to experience stimulation	4.50	1.20	4.91	0.26	4.43	0.20	4.75	.36	28.633	.000
4. Extrinsic – external regulation	1.75	-1.54	4.79	0.14	4.37	0.14	4.60	.76	25.765	.000
5. Extrinsic – introjected	3.00	-0.29	4.69	0.04	4.15	-0.07	4.49	.76	10.853	.000
6. Extrinsic – identified	3.25	-0.04	4.90	0.25	4.25	0.02	4.67	.50	49.400	.000
7. Amotivation	1.00	-2.29	1.17	-3.47	1.68	-2.54	1.31	.60	9.174	.000
8. Individual attraction to group – Task	2.33	-0.96	4.91	0.26	4.40	0.17	4.71	.51	84.488	.000
9. Individual attraction to group – Social	2.33	-0.96	4.80	0.15	4.40	0.17	4.63	.53	47.210	.000
10. Group integration - Task	3.67	0.37	4.86	0.21	4.24	0.01	4.65	.49	33.564	.000
11. Group integration - Social	2.33	-0.96	4.87	0.22	4.56	0.33	4.72	.55	38.291	.000
12. Technological literacy	5.00	1.70	4.94	0.29	4.58	0.35	4.88	.30	20.282	.000
13. Communication and collaboration	5.00	1.70	4.84	0.19	4.42	0.19	4.71	.47	10.097	.000
14. Information searching and processing	4.50	1.20	4.90	0.25	4.60	0.37	4.80	.31	12.860	.000
15. Digital citizenship	1.67	-1.62	4.95	0.30	4.51	0.28	4.81	.34	27.076	.000
16. Creativity and innovation	4.83	1.53	4.93	0.28	4.44	0.21	4.78	.36	28.523	.000

Table 6. Cluster analysis into meaningful groups of academic motivation, group cohesion and digital competence

Thus, Group 2 (N = 22, 21.56%), the largest group, was characterised by a high prevalence of intrinsic motivation alongside extrinsic motivation, group cohesion and high digital competence. Group 3 (N = 72,

70.58%) was associated with scores slightly below the overall study mean, with the highest prevalence of amotivation. Finally, Group 1 (N = 8, 7.84%), the smallest group, obtained scores well below the mean in motivation and group cohesion, although overall high scores were observed across the dimensions of digital competence.

The objective of this study was to examine the effect of an educational innovation programme on academic motivation, group cohesion and digital competence among university students. The first hypothesis proposed a significant improvement in academic motivation, group cohesion and digital competence following the implementation of the “PracTICS” project. This hypothesis was fully supported, as the paired-samples t-test revealed significant improvements across all three variables among university students.

A review of the scientific literature shows that the specific nature of this type of research makes it difficult to compare our findings with previous studies, given the limited number of educational innovation projects that are not only implemented but also evaluated in university contexts. Nevertheless, several studies provide findings that are somewhat comparable. Albaladejo-Blázquez et al. (2021) advocate project-based learning in small groups as a predictor of high levels of group integration and responsibility while reducing academic stressors. Ruiz-Robledillo et al. (2020) follow a similar line, advocating collaborative student work to foster group cohesion and academic motivation while improving teaching and learning processes. Oda (2020) highlights the influence of gamification on interest and the subjective perception of effort among university students. López et al. (2022) demonstrate that innovation programmes based on applications can significantly improve motivation and group cohesion by promoting effort and the achievement of common goals. Finally, Gleason et al. (2022) highlight the importance of university projects in developing students’ transversal skills.

The second hypothesis of the study concerned the positive relationships between intrinsic motivation, the different dimensions of group cohesion and teaching digital competence. The proposed hypothesis was supported, with the exception of one dimension of digital competence, as the correlational analysis revealed these bidirectional relationships.

On the one hand, most studies link intrinsic motivation to group cohesion in working teams, not only in university contexts but also in earlier educational stages. Focusing on the former, Abellán and Doménech (2016) link both variables to other basic psychological needs; Arana (2022) highlights the close relationship between these variables and participant cohesion in achieving shared goals; and Sánchez et al. (2022) report a similar trend associated with greater social skills.

On the other hand, the relationship between digital competence and intrinsic motivation appears to be positive given that, as previously mentioned, the use of educational technology in university classrooms can act as an incentive for students (Alonso et al., 2021). Several studies support this premise. Prieto (2020) associates educational gamification and other digital competences with greater motivation among university students. Pérez and Gértrudix (2021) link high levels of intrinsic motivation with high digital competence among university students, alongside improved academic performance.

Finally, very few studies in university contexts have examined the relationship between group cohesion and digital competence, although several have approached the issue from different perspectives. Valerio (2022) relates both variables to the promotion of cooperative learning among students. Sumary (2021) argues that promoting students’ digital skills is fundamental for fostering cohesion within working teams, thereby enhancing cooperative and collaborative learning. Finally, Bullon (2022) relates digital competence to group cohesion and emotional intelligence, together with improved academic performance.

Taken together, these findings support the proposed hypothesis and highlight the close relationship among the constructs examined in our study, namely intrinsic motivation, group cohesion and digital competence among university students.

The third hypothesis concerned the existence of significant behavioural patterns characterised by high levels of motivation, group cohesion and teaching digital competence. The proposed hypothesis was

confirmed, with a high percentage of students belonging to the largest group, characterised by adaptive behavioural patterns. This finding suggests that the project was well received and successfully implemented in accordance with its intended objectives.

These results invite comparison with other studies examining behavioural patterns among university students and linking the variables described above, although such research remains relatively scarce in the scientific literature. In this regard, Saputra et al. (2021) identified a pattern of adaptive behaviours characterised by high motivation and group cohesion during collaborative tasks among university students, together with high levels of family support and academic well-being. Trivedi and Patel (2020) identified an adaptive behavioural pattern characterised by high intrinsic motivation and digital competence among students. Finally, González-Zamar and Abad-Segura (2020) associated group cohesion with student engagement and motivation as facilitating factors for learning.

4. Conclusion

This study demonstrates that the proposed project has an effect on university students. On the one hand, the nature of the project enables them to use Information and Communication Technologies (ICT) to develop learning materials, providing a pedagogical combination that may prove valuable for their future professional practice. On the other hand, from teachers' perspectives, this approach may encourage and motivate them to design and evaluate such programmes from a functional point of view, adapting the academic content to be taught within any given subject.

Finally, the observed improvement in such important variables as academic motivation, group cohesion and digital competence indicates that the development of innovative practices in the university classroom can foster other academic and personal variables. This may benefit not only students' academic performance in quantitative terms, but also the promotion of adaptive behaviours and the development of psychological skills that contribute to the acquisition of transversal competences, ultimately leading to greater satisfaction with their studies and potentially higher levels of academic well-being and happiness.

5. Limitations of the Study

The main limitations of this study stem from the constraints associated with the longitudinal design, despite its suitability for assessing the effects of the proposed programme and its intended objectives. These limitations include the time required for data collection, which extended to approximately five months from the beginning to the end of the semester; participant attrition between the two measurement time points, as not all participants were present on both occasions, although the majority of the sample was retained; and potential selection bias arising from the inclusion of heterogeneous participants in the comparison groups. Another potential limitation concerns age, particularly the extent to which the observed changes may be attributable to developmental factors rather than solely to the effects of the programme. At the same time, participants presented varying initial levels of digital competence, meaning that they did not start from the same baseline and consequently their degree of learning and development throughout the programme was not uniform.

Finally, the sample size was relatively small, as is often the case in this type of research design, highlighting the need for future studies to expand the sample by including students from other academic years or subjects.

6. Future Research Directions

Regarding future research directions, expanding the variables under study by incorporating complementary constructs—such as academic commitment, engagement or perceived academic success—would be valuable. In addition, integrating other content into the project, such as artificial intelligence or augmented reality, could contribute to a more comprehensive and holistic approach. Furthermore, certain components of the project could be implemented across other subjects and fields of knowledge, thereby exploring new application possibilities, as well as among teachers working in early childhood and primary education settings.

Similarly, incorporating academic performance could play a prominent role in studies involving adolescent students, allowing researchers to examine the influence of the programme on this outcome.

Finally, involving other professionals who can contribute digital content to the programme could result in a more comprehensive project, fostering the integration and development of digital competence from different perspectives.

7. Practical Implications

The research conducted may have practical implications related to the promotion of pedagogical approaches based on the development of students' digital competence and aimed at fostering more adaptive behaviours, not only regarding the variables examined in this study but also in promoting other self-determined variables associated with effort, commitment and teamwork. These factors may enable students to experience a greater sense of achievement in their learning, thereby increasing their levels of well-being and academic happiness. In turn, promoting these variables in the classroom could support student engagement and act as a protective factor against course withdrawal, thereby contributing to students' academic progress. Furthermore, the development of innovative teaching programmes, projects or resources adapted to academic content may represent a good teaching practice from which students can benefit. At the same time, integrating higher education with other educational stages, as undertaken in the context of this research, may motivate students and future teachers by bringing classroom practice closer to university-based learning. Finally, the findings of this study represent a scientific contribution aimed at bringing together psychological variables that influence university students and promoting their optimal personal and socio-affective development.

Conflict of Interests

The authors declare no conflicts of interest regarding this research.

Funding

The authors received no financial support for the research, authorship or publication of this article.

Authors' contributions

Reina Castellanos-Vega: Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision.

Pablo Usán-Supervía: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision.

Julia Sánchez-García: Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision.

Data availability

Data available upon request.

Use of Artificial Intelligence

The authors declare that the content of the article has not been developed using Artificial Intelligence.

References

Abellán, L., & Doménech, F. (2016). Relación entre las necesidades psicológicas y la motivación intrínseca en una muestra de estudiantes universitarios. In J. Castejón (Coord.), *Psicología y Educación: Presente y Futuro*. Universidad de Alicante. <https://hdl.handle.net/10045/64097>

- Albaladejo-Blázquez, N., Sanchez-SanSegundo, M., RodesLloret, F., PastorBravo, M. D. M., Muñoz-Quirós Caballero, J. M., DíezJorro, M., & Carrillo-Minguez, C. (2021). Trabajo colaborativo online a través del Aprendizaje Basado en Proyectos como estrategia en estudiantes universitarios. In R. Satorre (Dir.), *Memòries del Programa de Xarxes-I3CE de qualitat, innovació i investigació en docència universitària. Convocatòria 2020-21* (pp. 1–20). Universitat de Alicante. <https://rua.ua.es/server/api/core/bitstreams/d16c85f6-01dd-46be-96c1-326f4175d2f0/content>
- Almazroa, H., & Alotaibi, W. (2023). Teaching 21st century skills: Understanding the depth and width of the challenges to shape proactive teacher education programmes. *Sustainability*, 15(9), 7365. <https://doi.org/10.3390/su15097365>
- Alonso, S., Martínez, J.A., Berral, B., & De la Cruz, J.C. (2021). Gamificación en Educación Superior. Revisión de experiencias realizadas en España en los últimos años. *Hachetetepe. Revista Científica de Educación y Comunicación*, 23, 2205. <https://doi.org/10.25267/Hachetetepe.2021.i23.2205>
- Antepara, E.H. (2022). La importancia de la pedagogía en la práctica docente universitaria. *Pro Sciences: Revista de Producción, Ciencias e Investigación*, 6(45), 136–147. <https://doi.org/10.29018/issn.2588-1000vol6iss45.2022pp136-147>
- Arana, P. (2022). *Programa de orientación e intervención psicopedagógica para incentivar la motivación intrínseca en los estudiantes universitarios de la Facultad de Derecho y Ciencia Política del segundo ciclo en una universidad pública de Lima* (Master's Thesis). Universidad San Ignacio de Loyola. <https://hdl.handle.net/20.500.14005/12262>
- BOE (2020). Ley Orgánica 3/2020, de 29 de diciembre, por la que se modifica la Ley Orgánica 2/2006, de 3 de mayo, de Educación. *Boletín Oficial del Estado*, 340, 122868-122953, de 30 de diciembre de 2020. <https://www.boe.es/eli/es/lo/2020/12/29/3/dof/spa/pdf>
- Bullon, O. (2022). *Competencias digitales, trabajo colaborativo e inteligencia emocional en el rendimiento académico de estudiantes de secundaria en una institución educativa* (Bachelor's Thesis). Universidad César Vallejo. <https://dialnet.unirioja.es/servlet/tesis?codigo=350707&orden=0&info=link>
- Cabero, J., Barroso, J., Gutiérrez, J., & Palacios-Rodríguez, A. (2020). Validación del cuestionario de competencia digital para futuros maestros mediante ecuaciones estructurales. *Bordón*, 72(2), 45–63. <https://doi.org/10.13042/Bordon.2020.73436>
- Carhuajulca, A. (2021). *Engagement y factores asociados: una revisión sistemática, 2020* (Bachelor's Thesis). Universidad Cesar Vallejo. <https://hdl.handle.net/20.500.12692/54815>
- Checa, I., & Bohórquez, M. (2020). Medidas psicométricas de la cohesión en equipos de trabajo universitarios. *Retos*, 37, 108–114. <https://doi.org/10.47197/retos.v37i37.67379>
- Cobo-Rendón, R., López-Angulo, Y., Sáez-Delgado, F., & Mella-Norambuena, J. (2022). Engagement, motivación académica y ajuste de estudiantado universitario. *Revista Electrónica Educare*, 26(3), 256–274. <https://doi.org/10.15359/ree.26-3.15>
- Coelho, M. & Menezes, I. (2021). University social responsibility, service learning, and students' personal, professional, and civic education. *Frontiers in Psychology*, 12, 617300. <https://doi.org/10.3389/fpsyg.2021.617300>
- Deci, E. & Ryan, R. (Eds.). (2002). *Handbook of self-determination research*. University of Rochester Press.
- García, M.D., Reyes, J., & Godínez, G. (2017). Las Tic en la educación superior, innovaciones y retos. *RICSH Revista Iberoamericana de las Ciencias Sociales y Humanísticas*, 6(12), 1–19. <https://doi.org/10.23913/ricsh.v6i12.135>
- Gleason, M.A., Rubio, J.E., Ruíz, J.A., & Velázquez, M.L. (2022). Proyectos de innovación social como estrategia para el desarrollo de competencias de estudiantes universitarios. *Revista de la Educación Superior*, 51(202), 69–88. <https://doi.org/10.36857/resu.2022.202.2118>

- González, A.M.F., & Dueñas, E.J.G. (2022). Las TIC en la promoción de lectura, implicaciones científico-técnicas en/para el contexto educativo. *Revista Científica Cultura, Comunicación y Desarrollo*, 7(3), 55–62. <https://rccd.ucf.edu.cu/index.php/aes/article/view/392>
- González-Zamar, M.D., & Abad-Segura, E. (2020). Diseño del espacio educativo universitario y su impacto en el proceso académico: análisis de tendencias. *Revista de Estilos de Aprendizaje*, 13(25), 1–13. <https://doi.org/10.55777/rea.v13i25.1512>
- Goodwin, J. (2024). What's the Difference? A Comparison of Student-Centered Teaching Methods. *Education Sciences*, 14(7), 736. <https://doi.org/10.3390/educsci14070736>
- Hendrie, K., & Bastacini, M. (2020). Autorregulación en estudiantes universitarios: Estrategias de aprendizaje, motivación y emociones. *Revista Educación*, 44(1), 1–29. <https://doi.org/10.15517/revedu.v44i1.37713>
- Leiva, J., Alcalá, M., García, F. & Santos, M. (2022). Promoción de competencias interculturales y uso de las TIC: Hacia una universidad inclusiva. *REICE. Revista Iberoamericana Sobre Calidad, Eficacia y Cambio en Educación*, 20, 47–64. <https://doi.org/10.15366/reice2022.20.2.003>
- Leo, F., González-Ponce, I., Sánchez-Oliva, D., Pulido, J., & García-Calvo, T. (2015). Adaptation and validation in Spanish of the Group Environment Questionnaire (GEQ) with professional football players. *Psicothema*, 27(3), 261–268. <https://doi.org/10.7334/psicothema2014.247>
- Lion, C. & Maggio, M. (2019). Desafíos para la enseñanza universitaria en los escenarios digitales contemporáneos. Aportes desde la investigación. *Cuadernos de Investigación Educativa*, 10(1), 13–25. <https://doi.org/10.18861/cied.2019.10.1.2878>
- López, M.G., Sánchez, D.M., Alcaraz, B.J.S., & Valenzuela, A.V. (2022). “The War of the Athletes”: una propuesta de gamificación aplicada a la docencia universitaria para favorecer los valores educativos y la responsabilidad. *Espiral. Cuadernos del Profesorado*, 15(30), 38–50. <https://doi.org/10.25115/ecp.v15i30.6718>
- Morales, S. (2021). La motivación al aprendizaje en la Educación Virtual Universitaria. *Revista Guatemalteca de Educación Superior*, 4(2), 42–49. <https://doi.org/10.46954/revistages.v4i2.61>
- National Institute of Educational Technologies and Teacher Training (2025). *Marco de referencia de la competencia Digital*. INTEF. <https://aprende.intef.es/mccdd>
- Nieto, N.L., García, S., & Nieto (2021). Relaciones de la motivación con la metacognición y el desempeño en el rendimiento cognitivo en estudiantes de educación primaria. *Anales de Psicología*, 37(1), 51–60. <https://doi.org/10.6018/analesps.37.1.383941>
- Núñez, J., Martín-Albo, J., & Navarro, J. (2010). Psychometric properties of the Educational Motivation Scale in University Students. *The Spanish Journal of Psychology*, 13(2), 1012–1020. <https://www.psicothema.com/pii?pii=3110>
- Oda, H. (2020). *La gamificación: una revisión sistemática y proyecto innovador con relación a la motivación y percepción subjetiva del esfuerzo* (Master's Thesis). Universidad de La Laguna. <http://riull.ull.es/xmlui/handle/915/19788>
- Paredes, R. & Silva, M. (2022). Percepción del trabajo en equipo y de las habilidades sociales en estudiantes universitarios. *Puriq*, 4, e265. <https://doi.org/10.37073/puriq.4.265>
- Pegalajar-Palomino, M.C. (2020). Relación entre la motivación académico-personal del estudiante novel en educación y las estrategias de trabajo autónomo. *Formación universitaria*, 13(5), 257. <https://doi.org/10.4067/S0718-50062020000500257>
- Pérez, E. & Gértrudix, F. (2021). Ventajas de la gamificación en el ámbito de la educación formal en España. Una revisión bibliográfica en el periodo de 2015-2020. *Contextos educativos: Revista de educación*, 28, 203–227. <https://doi.org/10.18172/con.4741>

- Prieto, J. (2020). Una revisión sistemática sobre gamificación, motivación y aprendizaje en universitarios. *Teoría de la Educación. Revista Interuniversitaria*, 32(1) 73-99. <https://doi.org/10.14201/teri.20625>
- Quispe, M. (2020). *Cohesión familiar y autoestima en estudiantes de una institución pública* (Licentiate Thesis). Universidad Católica los Ángeles de Chimbote. <https://hdl.handle.net/20.500.13032/17952>
- Rojas, D., Jiménez-Fernández, S. & Martínez-Heredia, N. (2019). El Trabajo Cooperativo como Herramienta Formativa en los Estudiantes Universitarios. REICE. *Revista Iberoamericana sobre Calidad, Eficacia y Cambio en Educación*, 17(3). <http://www.10.15366/reice2019.17.3.003>
- Ruiz-Robledillo, N., Ferrer-Cascales, R., Clement-Carbonell, V., Alcocer-Bruno, C., Fernández-Alcántara, M., Portilla-Tamarit, I., Zaragoza-Martí, A., Fernández-Ávalos, M. I., Sempere-Ortells, M., & Peral-Rodríguez, T. (2020). Aprendizaje colaborativo para la mejora de los procesos de enseñanza-aprendizaje en el contexto universitario. In R. Roig-Vila (Coord.), *Memorias del Programa de Redes-I3CE de calidad, innovación e investigación en docencia universitaria. Convocatoria 2019-20* (pp. 1213-1219). Universidad de Alicante. <https://hdl.handle.net/10045/112386>
- Salvador, C. (2021). Motivación de logro y metas en la vida: Rol mediador de la inteligencia emocional. *Electronic Journal of Research in Education Psychology*, 19(53), 1–18. <https://doi.org/10.25115/ejrep.v19i53.3317>
- Sánchez, D. (2021). Diferencias entre aspectos psicológicos en Educación Primaria y Educación Secundaria. Motivación, Necesidades psicológicas básicas, Responsabilidad, Clima de aula, Conductas antisociales y Violencia. *Espiral. Cuadernos del Profesorado*, 14(28), 9–18. <https://doi.org/10.25115/ecp.v14i28.4198>
- Sánchez, L., Escalante, S. & Vázquez, L.M. (2022). Motivación de los estudiantes universitarios de Ciencias de la Educación según género, cultura religiosa y habilidad social durante la pandemia de COVID-19. *Educar*, 58(1), 205–220. <https://doi.org/10.5565/rev/educar.1353>
- Saputra, N., Nugroho, R., Aisyah, H., & Karneli, O. (2021). Digital skill during covid-19: effects of digital leadership and digital collaboration. *Jurnal Aplikasi Manajemen*, 19(2), 272–281. <https://doi.org/10.21776/ub.jam.2021.019.02.04>
- Sumary, W.C.M. (2021). Las competencias digitales en la Educación Virtual Universitaria. *Yachay-Revista Científico Cultural*, 10(1), 539–546. <https://doi.org/10.36881/yachay.v10i1.386>
- Tomás, J.M., & Gutiérrez, M. (2019). Aportaciones de la teoría de la autodeterminación a la predicción de la satisfacción escolar en estudiantes universitarios. *Revista de Investigación Educativa*, 37(2), 471–485. <https://doi.org/10.6018/rie.37.2.328191>
- Torralbas, J.E., & Cabrera, R.E. (2019). Análisis de la cohesión grupal en escuelas de enseñanza media-superior especializada en La Habana. *Universidad de La Habana*, (288), 105–127. <https://revistas.uh.cu/revuh/article/download/2524/2222>
- Torrice, M.G.C., Fernández, M.B., Pareja, E.F.H., & Millán, A.J. (2022). Innovación docente para la igualdad y para la diversidad en las políticas universitarias de España. *Aula abierta*, 51(1), 75–84. <https://doi.org/10.17811/rifie.51.1.2022.75-84>
- Trivedi, S., & Patel, N. (2020). Clustering Students Based on Virtual Learning Engagement, Digital Skills, and E-learning Infrastructure: Applications of K-means, DBSCAN, Hierarchical, and Affinity Propagation Clustering. *Sage Science Review of Educational Technology*, 3(1), 1–13. https://www.researchgate.net/publication/362830733_Clustering_Students_Based_on_Virtual_Learning_Engagement_Digital_Skills_and_E-learning_Infrastructure_Applications_of_K-means_DBSCAN_Hierarchical_and_Affinity_Propagation_Clustering#fullTextFileContent
- Trujillo, F., & Bermúdez, J. (2020). Las dimensiones de la motivación de logro y su influencia en rendimiento académico de estudiantes de preparatoria. *Enseñanza e Investigación en psicología*, 2(1), 73–83. <https://doi.org/10.62364/6bsgzd44>

- Usán, P. & Salavera, C. (2018). Orientaciones de logro, burnout académico y satisfacción intrínseca hacia la escuela en estudiantes de Educación secundaria obligatoria. *Revista Electrónica Interuniversitaria de Formación del Profesorado*, 21(3), 19-33. <https://doi.org/10.6018/reifop.21.3.311371>
- Usán, P. & Salavera, C. (2020). *Gamificación educativa: Innovación en el aula para potenciar el proceso de enseñanza-aprendizaje*. Pregunta.
- Uysal, F. (2025). Investigation of Teaching-Learning Process in Teaching Principles and Methods Course in terms of Student-Centered Learning. *International Journal of Turkish Education Sciences*, 13(1), 509–556. <https://doi.org/10.46778/goputeb.1605289>
- Valerio, N. (2022). *Competencias digitales y el aprendizaje cooperativo en los estudiantes del tercer grado, nivel secundaria del distrito de Chincha Alta-Ica*. (Master's Thesis). Universidad César Vallejo. <https://hdl.handle.net/20.500.12692/100334>
- Varela, A. (2023). *La reflexión del profesor universitario desde el enfoque de Learner-centered. Propuesta de autoevaluación docente y su utilización en el desarrollo profesional* (Doctoral Thesis). Universidad de Sevilla. Repositorio Institucional de la Universidad de Sevilla. <https://hdl.handle.net/11441/143742>
- Velasco, A. (2023). *La importancia de la investigación en el docente y en el alumnado como estímulo de la innovación en la educación. Premios a programas de investigación en el ámbito nacional y de Castilla y León* (Master's Thesis). Universidad de Valladolid. <https://uvadoc.uva.es/handle/10324/59902>
- Vitai, Z., & Benke, M. (2021). Motivation to learn? An advanced exploratory study of learning motivation of Central-East European Business Students. *Marketing & Management*, 55(2), 27–35. <https://doi.org/10.15170/MM.2021.55.02.03>
- World Medical Association. (2000). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *JAMA*, 284(23), 3043–3045. <https://doi.org/10.1001/jama.284.23.3043>
- Yañez-Sepulveda, R. A., Hinojosa-Torres, C., Cortés-Roco, G., & Zavala-Crichton, J. P. (2024). Aprendizaje basado en proyectos y gamificación como estrategias de aprendizaje en la formación de profesores de Educación Física (Project-based learning and gamification as learning strategies in physical education teacher training). *Retos*, 60, 1–11. <https://doi.org/10.47197/retos.v60.107939>
- Yolnasdi, Y., Simatupang, W., Sukardi, S., & Fadillah, R. (2025). Effectiveness of Project-Based Cooperative Learning Model in Electrical Installation Practical Courses. *Salud, Ciencia y Tecnología*, 5, 1779–1789. <https://doi.org/10.56294/saludcyt20251779>
- Zuhri, Z., & Afriani, G. (2025). Implementing project-based learning to enhance 21st century skills among senior high school students. *Global Education Journal*, 3(2), 463–471. <https://doi.org/10.59525/gej.v3i2.716>

Published by OmniaScience (www.omniascience.com)

Journal of Technology and Science Education, 2026 (www.jotse.org)



Article's contents are provided on an Attribution-Non Commercial 4.0 Creative commons International License.

Readers are allowed to copy, distribute and communicate article's contents, provided the author's and JOTSE journal's names are included. It must not be used for commercial purposes. To see the complete licence contents, please visit <https://creativecommons.org/licenses/by-nc/4.0/>.