WHAT DO FUTURE EDUCATION PROFESSIONALS THINK ABOUT PEDAGOGICAL INNOVATION WITH DIGITAL TECHNOLOGIES?

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Abstract

Developing a critical understanding of the pedagogical potential of digital technologies has become a central goal in higher education programmes. However, students entering higher education bring with them a set of experiences that shape their perceptions of the role of digital technologies in education. Understanding these initial representations is therefore essential for designing educational pathways that challenge established conceptions and promote understandings aligned with principles of pedagogical innovation mediated by digital technologies. This study, carried out within a first-year curricular unit on "ICT in Education" in a bachelor's degree in education sciences, aims to analyse these representations through drawings produced by the students. In the first class, students were invited to draw a learning situation from their prior educational experience that, in their view, represented a scenario of pedagogical innovation involving digital technologies. The drawings (n = 27) were digitised and analysed based on five analytical dimensions established from the literature on pedagogical innovation and on technologies as "cognitive tools": focus on learners and learning; meaningful integration of technologies; methodological diversification; flexibility of learning spaces; and articulation between different forms of knowledge, including connections across subject areas and real-life contexts. The exploratory analysis revealed general trends in students' perceptions: digital technologies are frequently associated with isolated activities (such as quizzes or the use of projectors), embedded within predominantly transmissive and pedagogically undiversified practices. Although some indications of collaborative work emerge, these are limited, restricted to discipline-based logics and rarely grounded in a deeper understanding of pedagogical innovation with digital technologies. These initial representations, collected from first-year students in education sciences, provide a relevant diagnostic and justify ongoing work aimed at fostering a more critical, creative, and sustained understanding of the pedagogical integration of digital technologies. They also reflect the educational practices experienced by the students throughout their schooling, often marked by instrumental uses of digital technologies focused on transmission and memorisation of curricular content. This finding reinforces the importance of promoting, from the outset of higher education programmes, opportunities that challenge established conceptions, broaden pedagogical repertoires and support the development of more innovative and pedagogically grounded understandings of the educational potential of digital technologies.

Keywords: Pedagogical innovation, learning with technologies, higher education, student representations, visual methods.

1 INTRODUCTION

In the current educational context, marked by recurring discourses on innovation, transformation and digitalisation, pedagogy establishes itself as a fundamental reference for understanding and guiding any educational intervention, preceding and framing any discussion about the methods, resources or technologies used in educational settings [1]. Preparing future educators for the intentional use of technologies in diverse learning contexts, therefore, requires a deep understanding of how pedagogical choices and beliefs influence teaching and learning practices [2]. In the context of higher education programmes in education sciences, this issue assumes particular relevance, as highlighted by Robin Schmidt [3], since such beliefs decisively shape the reality of technology use in the classroom, making their critical reflection and confrontation with scientific knowledge in education indispensable.

In line with this perspective, and focusing on the concept of pedagogical innovation, the literature has shown that it tends to be conceptualised as an intentional, situated and reflective process of transforming educational practices [1], [4], [5], [6]. As argued by Maria do Céu Roldão [7], it is ultimately in the way teaching is enacted that the potentialities enabling and facilitating others' learning are found. This perspective is reinforced by Bates [8], [9], who emphasises that pedagogical decisions should result from a conscious articulation between teaching philosophy, learners' needs, the demands of disciplinary areas and the available resources. Thus, teaching, from the perspective of pedagogical innovation with technologies, is not reduced to the mere transmission of information nor to the use of more or less

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sophisticated resources and tools. Rather, it is a purposeful and reflective activity, guided by criteria of value and understanding, aimed at creating conditions for others to understand and construct meanings with technologies [10], [11], [12], [13].

Consistent with this, research highlights that when technologies are used uncritically, they tend to reproduce traditional, transmissive practices and fail to support the development of twenty-first-century skills [9]. Conversely, when integrated in a pedagogically intentional manner, they can foster learner-centred approaches, cognitive engagement and the construction of socially relevant knowledge. It is precisely in this sense that David Jonassen conceptualises technologies as "cognitive tools" [10], [11], arguing that they should support complex thinking, analysis, reflection, and knowledge representation. From this perspective, students cease to be passive learners and assume the role of active designers of learning, using tools to explore problems, organise meanings, construct personal interpretations and communicate what they know to others. Therefore, rather than merely placing technologies in students' hands to "find, accumulate and manage rudimentary information from disciplinary domains" [14, p. 92], it is important to frame them within integrative approaches that promote articulation between different disciplinary areas and real-life contexts and, consequently, strengthen the construction of transferable and meaningful learning [14], [15], [16].

Maintaining the focus on students' activity also requires recognising the heterogeneity of learners and the need to create inclusive educational environments, which, on the part of the teacher, demands a high level of pedagogical intentionality and critical reflection on educational choices [12]. Addressing this challenge, Paniagua and Istance [1] suggest combining different pedagogical approaches, noting that innovative pedagogies tend to align with learners' natural inclinations towards play, curiosity, and social interaction. This entails the design and implementation of strategies that make the learning experience more enjoyable, interesting, engaging and, consequently, more effective [6], [13]. In parallel, the process of innovation and transformation of pedagogical practices also calls for a reconfiguration of learning spaces, requiring, on the one hand, greater attention to the creation of more flexible environments that promote higher levels of well-being, comfort and ergonomics [17]. On the other hand, it encourages different working dynamics that are not confined to the "four walls" of the classroom or to the rigidity of school timetables. In this respect, as evidence from research shows, digital technologies can also play a highly relevant role, enabling the creation of personalised and collaborative learning opportunities and experiences that promote continuity of learning and connection to broader formal and informal contexts [6], [16], [18].

Considering the various facets addressed in the literature reviewed here, pedagogical innovation with digital technologies is configured, within the scope of this study, as a multidimensional construct that articulates several interrelated aspects of teaching and learning. It is understood as an approach that requires pedagogical intentionality to create conditions for learners to construct meanings with technologies, encompassing: (1) a focus on learners and learning, recognising their diverse needs, prior knowledge, and experiences; (2) meaningful integration of technologies, ensuring digital tools are used purposefully to support learning; (3) methodological diversification, promoting active, collaborative, and personalised approaches; (4) flexibility of learning spaces, creating adaptable, engaging, and comfortable environments; and (5) articulation between different forms of knowledge, including connections across subject areas and real-life contexts. This integrative conceptualisation emphasises that pedagogical innovation is not a collection of isolated practices, but a system of interdependent pedagogical decisions, guided by principles that foster deep, meaningful, and learner-centred educational experiences in contexts mediated by digital technologies.

Based on this understanding, the present study seeks to understand how first-year undergraduate students in education sciences conceptualise pedagogical innovation with digital technologies, through the analysis of drawings produced at the beginning of a curricular unit on "ICT in Education". By exploring the initial representations of future education professionals, the aim is to access prior subjective conceptions and experiences, which are not always easily verbalised, but are fundamental for promoting critical reflection and providing contrasting experiences that allow traditional beliefs to be questioned and shifted towards views more aligned with contemporary pedagogical demands [1], [3], [4], [6], [15], [17]. Following the work of Sheridan [19], it is assumed that teaching in the initial education of education professionals can be strengthened through an in-depth understanding of their initial pedagogical beliefs, in this case, regarding scenarios of pedagogical innovation with digital technologies.

2 METHODOLOGY

This study employs a qualitative, exploratory, and descriptive approach, grounded in a categorical analysis of students' drawings and their accompanying captions. The use of drawing is informed by a methodological perspective that recognises it as a legitimate source of qualitative data, particularly suitable for accessing representations, conceptions, and prior experiences that are not always easily articulated through exclusively verbal means [20], [21]. Within this study, we aimed to explore the initial conceptions of higher education students regarding innovative pedagogical practices with digital technologies, before they were exposed in depth to such practices in their higher education programme.

The study was conducted with first-year undergraduate students enrolled in the degree programme in education sciences, within the context of the curricular unit "ICT in Education", which is part of the programme's study plan. At this initial stage of their education, students had not yet been exposed to the study of innovative pedagogical approaches with technologies, highlighting the relevance of analysing their initial conceptions. Data collection took place during the first session of the curricular unit, in which students were invited to produce, individually, a drawing representing a learning situation they had experienced during their educational trajectory and which, from their perspective, constituted an example of pedagogical innovation involving the use of digital technologies. The resulting corpus consists of 27 drawings, each accompanied by a descriptive caption, allowing for a more informed interpretation, especially in cases where the graphic representations are very simple.

For the analysis of the drawings, a coding grid was developed, anchored in the conceptualisation of pedagogical innovation with digital technologies presented in the introduction, which integrates and organises the key elements discussed in the literature. Accordingly, this framework comprises five analytical dimensions, conceived as abstract axes that structure conceptions and practices of pedagogical innovation with digital technologies: (1) focus on learners and learning; (2) meaningful integration of digital technologies; (3) diversification of teaching and learning methodologies; (4) flexibility of learning spaces; and (5) articulation between different forms of knowledge. Each dimension was operationalised through a guiding question and a four-level rating scale (0–3), which describes progressive degrees of evidence of the observable indicators in the drawings and their respective captions. Table 1 presents a simplified version of the coding grid developed and used in this study.

Table 1. Coding Grid (simplified version).

Dimension	***Guiding question***	***0 – Absence of elements***	***1 – Limited presence***	***2 – Moderate presence***	***3 – Strong presence***
Dimension 1 (Learners)	Are learners actively involved, assuming responsibility for the learning process, or are they limited to being recipients of information?	Learners are not depicted, and it is not possible to infer who is learning from the drawing or the caption.	Learners are represented passively or with minimal involvement (e.g. listening, observing, copying, following instructions).	Learners carry out activities or interact with resources, but with limited autonomy and predominantly external guidance.	Learners are active agents of learning: they collaborate, make decisions, explore, create or construct knowledge.
Dimension 2 (Technologies)	Are technologies used as "cognitive tools" in the service of learning, or as support for teaching?	Technology is not represented or is not related to learning.	Technology appears mainly as support for teaching or as an object of technical study.	Technology supports students' learning activities (e.g. searching, exercises, recording information), in a predominantly individual and guided manner.	Technology functions as a cognitive tool, mediating thinking, creation, collaboration or the solving of complex problems.
Dimension 3 (Methodologies)	Does the scenario include active and diversified methodologies, or does it tend to reproduce transmissive, teacher-centred teaching?	The scenario does not allow the type of teaching and learning methodologies to be inferred from the drawing or the caption.	The scenario shows the predominance of a transmissive, teacher-centred methodology, possibly including the use of digital technologies without substantive changes to practices.	The scenario reveals occasional indications of active methodologies (e.g. individual work with technology, limited interaction), but with little articulation or integration within the learning scenario.	The scenario shows active and diversified methodologies (collaboration, creation, research, problem solving, presentations), visible in the drawing or described in the caption.

Dimension 4 (Spaces)	Does the organisation of space facilitate interaction and cooperation, or does it maintain rigid structures?	The learning space is not represented or is indeterminate.	The space reflects a traditional, rigid and individualised organisation.	The space shows some flexibility in organisation and interaction among students.	The space is flexible, hybrid or expanded, fostering collaboration, mobility and connection to broader contexts.
Dimension 5 (Articulation)	Does the scenario establish links between different areas of knowledge or with real-life contexts?	The scenario does not allow any articulation between forms of knowledge or contexts to be inferred.	The scenario suggests a clearly disciplinary and isolated logic of work (e.g. explicit reference to a subject, textbook or specific content).	The scenario suggests occasional links to real-life contexts or applicability of knowledge, without explicit interdisciplinary integration.	The scenario shows intentional articulation between different forms of knowledge, in interdisciplinary projects or meaningful everyday problems.

To ensure efficient systematisation and organisation of the classifications, the framework was implemented using Google Forms. The drawings were analysed by examining both the graphic elements and the explanatory captions provided by the students. Coding was conducted independently by two researchers using the digital form, with any discrepancies in classification subsequently discussed and resolved through consensus. Once coding was completed, the data were systematised both globally and by dimension, through frequency counts of the levels assigned to the drawings. In line with the exploratory and qualitative nature of the study, this quantification was intended to support the qualitative analysis, allowing the identification of general trends without compromising the interpretation of the meanings expressed in the corpus. In accordance with principles of good practice in scientific research, all drawings were treated in a rigorously anonymised manner through the assignment of sequential alphanumeric codes (D01 to D27).

3 RESULTS

The results presented in Table 2 provide a comprehensive overview of the distribution of drawings across the different levels for each of the five analysed dimensions, forming the basis for the detailed description in the following subsections.

Table 2. Overall distribution of drawings by analysis level in each dimension (N = 27).

Dimension	*Level 0*		*Level 1*		*Level 2*		*Level 3*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Dimension 1 (Learners)	2	7.4	12	44.4	9	37.0	3	11.1
Dimension 2 (Technologies)	1	3.7	17	63.0	6	22.2	3	11.1
Dimension 3 (Methodologies)	2	7.4	10	37.0	11	40.7	4	14.8
Dimension 4 (Spaces)	0	0.0	16	59.3	8	29.6	3	11.1
Dimension 5 (Articulation)	4	14.8	18	66.7	5	18.5	0	0.0

3.1 Dimension 1 - Focus on Learners and Learning

The analysis of the results obtained for Dimension 1 shows that active learner participation in contexts involving digital technologies is still at an early stage, with two drawings even classified at Level 0 (7.4%, N=2). The visual representation in both cases is entirely focused on classroom infrastructure and equipment, with no indication of who is learning or how learning occurs. At the opposite extreme, only three drawings reached Level 3 (11.1%, N=3), illustrating scenarios in which learners are depicted as active agents, either assuming the role of investigators using technologies to “conduct a study” or as creative producers engaged in the audiovisual production of a digital artefact.

The vast majority, however, falls within the intermediate levels of the scale (81.5%, N=22), particularly Level 1 (44.4%, N=12), in which students are mainly represented as passive recipients of instruction, with no visible action or significant autonomy. At Level 2 (37%, N=10), scenarios show learners using technologies to carry out concrete activities, notably research, data recording, exercise completion, or interactive assessment activities (e.g., Quizizz, Kahoot). Despite these indications of cognitive engagement, autonomy in these cases remains limited, with no explicit forms of collaboration or decision-making processes regarding their own learning being evident.

Taken together, these results suggest that students' representations reflect conceptions of learning shaped by predominantly traditional school experiences, in which active participation with digital technologies is not yet fully established.

3.2 Dimension 2 - Meaningful integration of digital technologies

As in the previous dimension, the vast majority of drawings are concentrated at the intermediate levels, accounting for 85.2% (N=23). In this dimension, this reflects predominantly instrumental uses of technologies, underutilising their potential as mediators of knowledge construction. In particular, Level 1 predominates (63.0%, N=17), with representations of learning scenarios in which technologies appear primarily as support for teaching (e.g., content projection) or as objects of technical study (learning about technologies), with no evidence of cognitive mediation or promotion of complex learning.

A smaller set of drawings falls within Level 2 (22.2%, N=6). In these cases, digital technologies are mobilised in a more integrated way, supporting activities such as research, information comparison, data recording, or completion of specific tasks. Even so, these uses tend to remain confined to controlled contexts, with limited integration of technologies in service of analysis, reflection, or active knowledge construction. Strong evidence of meaningful integration of technologies is scarce, corresponding to only three drawings at Level 3 (11.1%, N=3). In these representations, digital technologies play a central role in the learning process, allowing learners to investigate, create, make decisions, and construct knowledge more autonomously and collaboratively.

Finally, one drawing was classified at Level 0 (3.7%, N=1) for not including any elements of digital technology. Although the learning activity represented is relevant, particularly in the domain of scientific observation, the tool depicted is analogue (microscope), highlighting the need to clarify basic concepts, notably the distinction between digital and analogue technology.

3.3 Dimension 3 - Diversification of teaching and learning methodologies

Analysis of the results for Dimension 3 shows that, although this dimension exhibits the highest concentration at Levels 2 and 3, methodological diversification in contexts with digital technologies remains relatively limited. Most drawings are still positioned at the intermediate levels of the scale (77.7%, N=21), reflecting an incipient conceptualisation of pedagogical innovation in terms of teaching and learning strategies.

At Level 1 (37%, N=10), representations of teacher-centred, transmissive, or rigidly structured lessons predominate, in which technologies appear primarily as support for content presentation. Some drawings depict "televised lessons" or lecture-style sessions focused on practice and memorisation, while others show students arranged in rows facing the teacher, with no signs of active participation. Level 2 is the most represented, with eleven drawings (40.7%, N=11), revealing scenarios with some methodological diversification, reflected in students' engagement in more active activities, such as research, task completion, or information recording. This level also includes scenarios depicting activities dedicated to "revision" and "digital formative assessment" (Kahoot, Quizizz), which allow greater interaction but remain within teacher-defined boundaries.

As in the previously analysed dimensions, the number of drawings classified at Level 3 is small (14.8%, N=4), yet they illustrate significant contrasts to the predominant transmissive models. In these cases, digital technologies are integrated within activity frameworks that demonstrate clearly active methodologies, such as projects, inquiry, collaborative work, and creative production. Finally, with no elements depicted, two cases are classified at Level 0 (7.4%, N=2), providing insufficient information to infer any methodological choice, as the drawings neither represent learners nor describe activities.

3.4 Dimension 4 - Flexibility of learning spaces

Regarding Dimension 4, the results indicate that the pedagogical practices with digital technologies depicted in the drawings occur predominantly in inflexible spaces, reflecting conceptions still strongly anchored in traditional spatial models. Overall, no drawings were classified at Level 0 (0%, N=0), indicating that all participants represented some type of learning space, even if traditional.

The majority of drawings fall within the intermediate levels of the scale (88.9%, N=24), with Level 1 accounting for most cases (59.3%, N=16). In these scenarios, individual desks or rows of students facing the teacher predominate, evidencing a spatial organisation oriented towards content delivery and individual work, with no signs of learner mobility, collaborative work zones, or connection with other learning contexts. Level 2 includes a smaller set of drawings (29.6%, N=8), showing some openness to spatial flexibility, with desk arrangements that foster peer interaction and, in some cases, illustrating non-formal learning contexts, such as home settings during emergency remote teaching. Despite these advances, the flexibility of spaces remains moderate, seemingly not the result of an explicit pedagogical intention.

Strong evidence of spatial flexibility is scarce, encompassing only three drawings classified at Level 3 (11.1%, N=3). These cases stand out clearly from the others, representing fieldwork environments or creative spaces adapted to the needs of pedagogical activities, resembling studios or creative laboratories. In these cases, learning spaces emerge as active resources, promoting mobility, interaction, collaboration, and meaningful engagement with real-world contexts, thereby transcending the “four walls” paradigm of the traditional classroom.

3.5 Dimension 5 - Articulation between different forms of knowledge

Analysis of the results for Dimension 5 indicates that the principle of articulating different forms of knowledge in the scenarios represented by students is clearly the most critical dimension. Overall, as in all dimensions, the vast majority of drawings are concentrated at the intermediate levels of the scale (85.2%, N=23). However, it is important to note the complete absence of representations classified at Level 3 (0%, N=0), indicating that no educational practices explicitly promoting interdisciplinarity, integrative projects, complex problem-solving, or intentional articulation across multiple domains of knowledge were observed. This dimension also shows the highest number of drawings classified at Level 0 (14.8%, N=4), indicating in these cases the absence of any visual or textual element suggesting the articulation of different forms of knowledge.

At Level 1, which encompasses the majority of drawings (66.7%, N=18), representations of strictly disciplinary learning predominate, characterised by the lack of explicit connections to other knowledge areas and the absence of links to meaningful real-world contexts. Activities focus on specific curricular content domains, notably Mathematics, ICT, Music, History, and Biology. Only a small set of five drawings falls within Level 2 (18.5%, N=5), representing educational practices with moderate articulation between different forms of knowledge, primarily manifested through elements that evidence contextualisation of learning in real-life situations or reference to the applicability of digital tools in the workplace. In these cases, there is some rapprochement between school and the real world, but with no clear evidence of genuinely interdisciplinary approaches, as the learning scenarios remain bounded by the limits of a discipline-based curriculum.

In summary, Dimension 5 reflects the predominance of a disciplinary approach, with some situated and isolated experiences indicating potential links between forms of knowledge, but without evidence of curricular integration or effective interdisciplinarity.

4 CONCLUSIONS

This study aimed to understand how first-year undergraduate students in the education sciences degree programme conceptualise pedagogical innovation with digital technologies, through the analysis of drawings produced at the beginning of the curricular unit “ICT in Education”. The results revealed patterns consistent with the literature, confirming that the transformative potential of digital technologies in school contexts is often underutilised [3], [6], [12]. In most cases, technologies are integrated into conservative pedagogical practices, focused on content transmission and exhibiting limited methodological diversification, thus reproducing traditional teaching models, even when mediated by digital resources [1], [3], [12].

Although isolated indications of more active methodologies, situated learning, and the use of technologies to support learners' cognitive engagement were observed [10], [11], these practices appeared sporadically and without systematic articulation. In particular, the articulation between different forms of knowledge emerged as the most critical dimension, with no representations explicitly evidencing interdisciplinary approaches, integrative projects, or practices aimed at resolving complex problems. This finding aligns with studies highlighting the persistence of fragmented curricula [14] and the difficulty of integrating digital technologies into intentionally interdisciplinary practices designed for deep and transferable learning [6], [15].

The flexibility of learning spaces in contexts involving digital technologies also remains limited, reflecting conceptions strongly anchored in traditional spatial configurations [17]. Within the scope of this study, rigid classroom layouts predominated, with fixed furniture arrangements, teacher-centred organisation, and limited learner mobility or interaction. Only a very small number of cases depicted genuinely flexible learning spaces, in which mobility, interaction, and collaboration among learners were facilitated. This pattern reflects prior educational experiences with limited exposure to innovative environments, corroborating evidence emphasising the slow transformation of school spaces, and their weak alignment with broader pedagogical changes [1], [17].

Taken together, these results suggest the need for intentionally designed educational interventions aimed at challenging traditional pedagogical conceptions, promoting diversified methodologies, enhancing the flexibility of learning spaces, and encouraging the articulation of different forms of knowledge. This need is strongly supported by research, which consistently demonstrates that the effective integration of digital technologies in educational contexts depends primarily on educators' beliefs and attitudes rather than on their technical or professional knowledge [2], [3].

Building on these findings, the multidimensional coding grid developed and applied in this study emerges as a significant contribution, both for research and teacher education. In addition to systematising the analysis of students' initial conceptions, its application demonstrated potential as a conceptual reference supporting pedagogical reflection and informed discussion of innovative educational practices. More than a normative instrument, the grid functions as an analytical tool that can be employed in diverse research and training contexts, enabling both prospective and in-service educators to structure, question, and deepen their own conceptions of pedagogical innovation with digital technologies, in critical dialogue with the scientific literature.

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