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Article

Innovation in education: a systematic analysis of literature reviews

Inovação em educação: uma análise sistemática de revisões de literatura

Innovación en la educación: un análisis sistemático de revisiones de literatura

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ABSTRACT

In debates about improvements in teaching and learning processes, questions about how innovations are understood and used in education are frequently implied. We conducted an exhaustive search and a systematic analysis of 66 literature reviews on educational innovation to understand how the topic is approached. We focused our analysis on understanding what innovation is, what types of innovations have been studied, and the main results pointed out by researchers in these areas. We identified nine articles that conceptualize innovation. The most investigated types of innovation are the use of digital resources in teaching and assessment strategies, with positive results in most cases. Factors that interfere with the adoption of innovations include curricular limitations and previous experience with innovation.

Keywords: Innovation. Education. Science Education.

RESUMO

Em debates sobre melhorias nos processos de ensino e aprendizagem, recorrentemente ficam subentendidas questões relativas a como as inovações são entendidas e utilizadas pela literatura científica na área da educação. Realizamos uma busca exaustiva e uma análise sistemática de 66 revisões da literatura sobre inovação educacional para entender como o tema é abordado. Voltamos nossa análise para compreender aquilo que é inovação, quais tipos de inovações têm sido estudadas e os principais resultados apontados pelos pesquisadores nessas áreas. Identificamos nove artigos que conceitualizam a inovação. Os tipos de inovação mais investigados são o uso de recursos digitais em estratégias de ensino e avaliação, com resultados sobretudo positivos. Fatores que interferem na adoção de inovações incluem limitações curriculares e experiência prévia com a inovação.

Palavras-chave: Inovação. Educação. Educação em Ciências.

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RESUMEN

En debates sobre mejoras en los procesos de enseñanza y aprendizaje, con frecuencia se subentienden cuestiones sobre cómo las innovaciones son comprendidas y utilizadas em el campo de la Educación. Realizamos un búsqueda exhaustiva y un análisis sistemático de 66 revisiones de la literatura sobre innovación educativa para entender cómo se aborda el tema en esta área. Nos centramos en comprender qué es la innovación, qué tipos de innovaciones han sido estudiadas y los principales resultados señalados por los investigadores en estas áreas. Identificamos nueve artículos que conceptualizan la innovación. Los tipos de innovación más investigados son el uso de recursos digitales en estrategias de enseñanza y evaluación, con resultados positivos sobre todo. Factores que interfieren en la adopción de innovaciones incluyen limitaciones curriculares y experiencia previa con la innovación.

Palabras clave: Innovación. Educación. Educación en Ciencias.

INTRODUCTION

Educational practices and knowledge inevitably become inadequate or obsolete due to the changes occurring in human societies over time. In response to this, to meet educational expectations, various solutions are sought. However, they all share the need to create and implement innovations. But what does the term *innovation* mean in the educational context?

There is a multiplicity of meanings associated with the concept of innovation and what is considered innovative. For instance, Everett Rogers defines innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12). Michael Fullan, on the other hand, suggests that innovation "relates to the content of a particular new program" (Fullan, 2009, p. 22, our translation), and innovative capacity "involves the skills of an organization to sustain continuous improvement" (Fullan, 2009, p. 22, our translation). These examples illustrate part of what is understood as innovation in the context of education, as there are still meanings attributed to the concept by researchers and educators who may use it vaguely or without a direct link to a theoretical framework.

Tavares (2019) explored how the term innovation is defined in scholarly articles published between 1974 and 2017 within the educational field, identifying it as polysemous. The conceptualizations identified by the author were categorized into four perspectives: *i*. a positive bias; *ii.* as synonymous with educational transformation and reform; *iii*. the adaptation of curricular proposals; and *iv*. changes in educational practices within a group.

To further this discussion and understand if there is a consensus, either explicit or implicit, on innovations within the research context in education, we conducted an analysis of literature review papers on innovation in these areas — examining the themes being studied and the key findings in this line of research. We focused our analysis on literature reviews to gain a deeper understanding of what research on this topic has already produced and to identify patterns that can contribute to ongoing discussions.

Unlike Tavares (2019), our search focused on literature reviews that may or may not explicitly define "innovation" and that indicated or not the impacts and factors affecting the adoption of innovations. We conducted searches for literature review articles on the Web of Science (Core

Collection) platform (WoSCP), published between the years 2000 and 2021. The set of reviewed articles was constituted through a mixed approach to article selection based on metadata and qualitative analysis of the papers. To encompass works on innovation in both formal and informal educational settings, which generally reflect on innovations related to school subjects, we excluded articles from the fields of education in: health sciences; business and management; arts and social sciences applied; and agricultural sciences. In the end, we reviewed a total of 66 fully analyzed literature review articles.

Our overarching research question was: *How has the theme 'innovation' been addressed in literature review research published in indexed journals in the WoSCP database within the field of education, between 2000 and 2021?*

This general question was broken down into two specific questions:

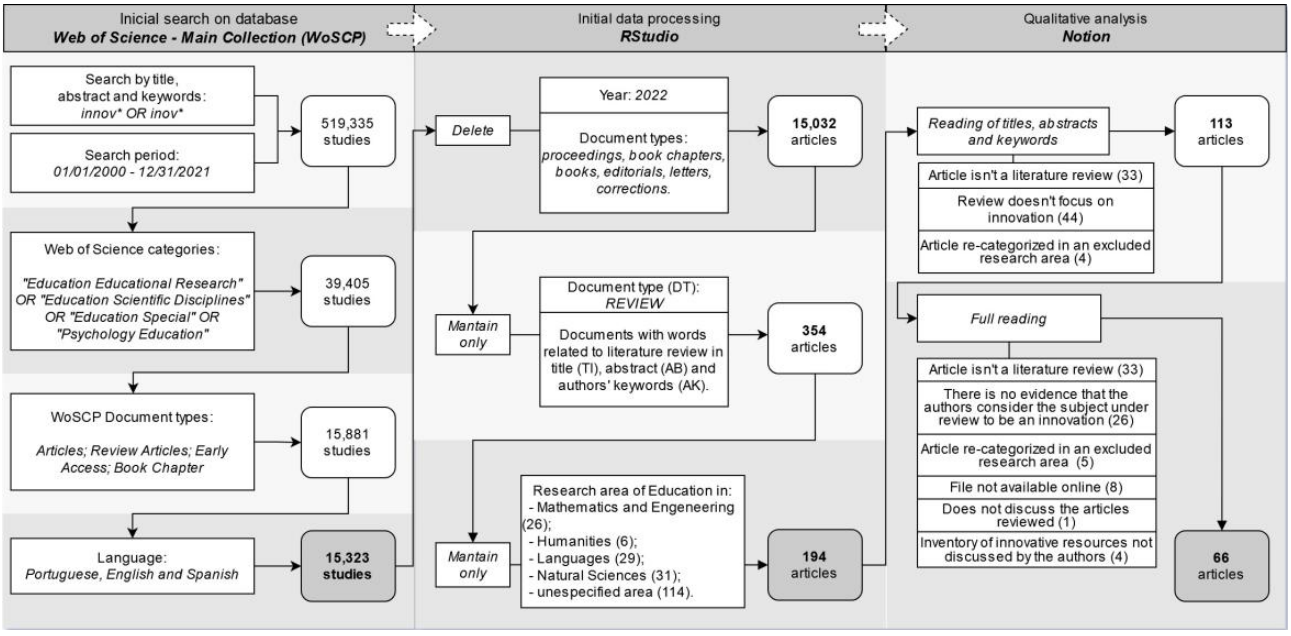
- *What is understood as innovation in these literature review papers?*
- *What are the main results related to the process of implementing innovations present in the literature reviews?*

Following this, we present the research methodology employed in this study, the results and discussions, and the final considerations.

METHODOLOGY

To provide an overview of research on the theme of innovation in the areas of education without a specific focus, and particularly in education in natural sciences and mathematics and languages and humanities, we conducted a systematic literature review guided by the methodological principles of Cooper, Hedges, and Valentine (2009). These principles include: 1. defining a research problem; 2. collecting research evidence; 3. evaluating the fit of methods and studies; 4. analyzing evidence from individual studies; 5. interpreting the accumulated evidence; and 6. presenting a synthesis of results and methods. Figure 1 provides a concise representation of the search and analysis process of the literature review papers that comprise the scope of this research.

Figure 1 – Search and selection of literature review articles.



Source: the authors (2022).

The chosen platform for the initial search for scientific articles on the theme was WoSCP, accessed through the Coordination for the Improvement of Higher Education Personnel (CAPES) Periodicals Portal. This choice was made due to the extensive coverage of internationally indexed journals and the availability of downloadable files containing the metadata of the studies (*e.g.*, title, publication year, author names, journal name).

Initially, we conducted a search in titles, abstracts, and keywords using the terms "innov* OR inov*"[1] from January 1st 2000 to 31st December 2021, with some restrictions applied: i. WoSCP categories related to education (education educational research, education scientific disciplines, education special, and psychology education); ii. document types (research articles, review articles, early access articles, and book chapters); and iii. language (Portuguese, English, and Spanish). At the end of this step, illustrated in the first column of Figure 1, a total of 15,323 studies were found.

Among the limitations of this selection, we highlight the choice of database (WoSCP), which primarily indexes journals in English. Other databases, such as Scopus, were also consulted; however, its limitation of downloading data — capping at two thousand articles — would not be feasible, given that the results returned by the platform were in the order of half a million articles.

Upon collecting the metadata of publications from the platform, we applied a filter to the papers using the R programming language and developing a custom code for this process. Initially, we removed metadata for works from the year 2022 due to issues of early access, and also removed those classified as event papers, retractions, editorial material, letters, corrections, and book chapters. We filtered the reviews based on document type and the presence of expressions related to literature reviews in titles, abstracts, and keywords (*e.g.*, review, meta-analysis, state-of-art). In this way, we selected 354 literature reviews on educational research across any field of knowledge. Subsequently, we excluded articles from the fields of education in: health sciences; business and management; arts and social sciences applied; and agricultural sciences. This filtering resulted in 194 articles. The center of Figure 1 illustrates the synthesis of selections and exclusions performed in this stage.

Next, we conducted a qualitative analysis based on the reading of titles, abstracts, and keywords, excluding from the analysis *corpus* articles that were not characterized as reviews or did not address the theme of innovation in education. The resulting articles (n=113) were read in full. During this stage, six exclusion criteria were applied: i. not a literature review article (n=3); ii. file unavailable for full reading (n=8); iii. no indications that the authors consider the reviewed theme as innovation (n=26); iv. does not discuss the reviewed articles (n=1); v shifted research area to one of the excluded fields during selection (n=5); and vi. inventory, or listing of innovative resources that are not discussed in depth by the authors (n=4). The third column of Figure 1 presents a synthesis of the selections and qualitative exclusions performed at this stage.

A total of 66 articles were considered relevant for our literature review. For the qualitative data analysis, a shared table was developed among researchers. Key information from this table includes categories such as area of knowledge, type of innovation investigated, the conceptualization of innovation adopted, and thematic focus (impact of innovations, barriers or limitations, and strategies or facilitators for their adoption).

Finally, we interpreted the information obtained through both the qualitative and quantitative analyses of the sample to establish conditions for a critical stance regarding the use of the concept of innovation in the fields of education (without a specific area) and, particularly, of education in natural sciences and mathematics and languages and humanities. The literature reviews that were the subject of our analysis are included in the references of this article, indicated with an asterisk (*).

1 Conducted in January 2022, the search utilized the resources provided by the database, such as using the asterisk character to search for any word derived from the root used and the logical operation OR.

RESULTS AND DISCUSSIONS

In this section, we discuss the results of the qualitative analysis of the 66 selected literature reviews. We begin by providing a contextualization of the studies, including information about the fields and educational levels addressed in the reviews. Next, we structure the discussion based on the two research sub-questions introduced earlier.

Regarding the fields of knowledge addressed in the reviews, most focus on education without specifying a particular disciplinary area (n=49). This substantial number of studies may reflect the nature of the innovations investigated, which are predominantly related to digital technologies and analyzed across a broad spectrum of disciplines and implementation contexts. Another 13 reviews were categorized under education in natural sciences, mathematics, and engineering. The remainder includes studies in the fields of education in humanities (n=1) and in languages (n=4), with one of the latter also classified under natural sciences. This distribution likely reflects a tendency to distance the analysis from the specific disciplinary context of innovation adoption. It also aligns with the inherent logic of these publications, which aim for broader generality to attract a wider readership and potentially increase citation impact. However, this general approach may limit the applicability of findings to specific contexts, potentially undermining their practical relevance.

During the full reading of the articles, we also identified the educational levels at which the innovations were investigated: higher education (n=23); basic education (n=17); both basic and higher education (n=11); unspecified (n=14); and non-formal education settings (n=1). This distribution reveals a predominance of studies focused on higher education. This trend may indicate a higher adoption rate of educational innovations at this level or simply reflect the academic community's particular interest in exploring innovations within higher education contexts.

WHAT IS UNDERSTOOD AS INNOVATION IN THESE LITERATURE REVIEW STUDIES?

In this section, we delve deeper into an understanding of what is considered *innovation* in the analyzed articles. We recognize that the way educational research approaches this issue is shaped both by the *conceptualizations of innovation* it adopts and by the *types of innovations* explored in the literature reviews, which will be discussed below.

CONCEPTUALIZATIONS OF INNOVATION

Few literature review articles endeavor to provide even minimal indications of what their authors, or the authors they review, understand by the term innovation. Among the 66 studies analyzed, only nine (approximately 13.6%) included excerpts clarifying its definition. There is no consensus among the highlighted definitions, which range from broad generalizations of innovation (*e.g.*, Morel *et al*., 2019; Moirano, Sánchez and Štěpánek, 2020) to specific ones, such as behavioral innovation (Carr, Kendal and Flynn, 2016), continuous, systematic, disruptive, or open innovation (Castillo-Martínez and Ramírez-Montoya, 2021), and educational innovation (Gresnigt *et al*., 2014; Rodríguez-Jiménez, Pérez-Ochoa and Ulloa-Guerra, 2021). In addition to the variety of definitions employed, the approaches authors take to organize their conceptualizations also differ. These include explicit declarative definitions (*e.g.*, López, Aroca and Abellán, 2020; Rodríguez-Jiménez, Pérez-Ochoa and Ulloa-Guerra, 2021), sequences of characteristics (Gresnigt *et al*., 2014; Carr, Kendal and Flynn, 2016), and conceptual models (Morad, Ragonis and Barak, 2021). Finally, regarding the origin of these definitions, seven studies adopted definitions from external sources, often in the form of theoretical frameworks. Only the definitions proposed by Carr, Kendal, and Flynn (2016) and Morad, Ragonis, and Barak (2021) emerged as a direct result of the review process undertaken.

Regarding the nature of conceptualizations, the authors of the reviews converge on a *processual notion of innovation*, portraying it as a series of actions unfolding over time — a process. However, while some explicitly articulate this idea (Carr, Kendal and Flynn, 2016; Morad, Ragonis and Barak, 2021), others imply it more subtly. In terms of the *depth of the changes* involved, the conceptualizations diverge: some authors highlight gradual or continuous changes (Carr, Kendal and Flynn, 2016; Castillo-Martínez and Ramírez-Montoya, 2021), whereas others emphasize the significance of disruption in the innovation process (López, Aroca and Abellán, 2020; Castillo-Martínez and Ramírez-Montoya, 2021).

Among the analyzed works, the study by Morad, Ragonis, and Barak (2021) stands out for its effort to establish a definition of innovation through an integrative review of explicit propositions from studies in various research fields. Their comprehensive model highlights five key elements: i. identifying a need or problem; ii. generating new or modified ideas; iii. developing an alternative based on these new ideas; iv. implementing a new or modified idea for a target audience; and v. adopting an innovation with recognized value.

The authors note that definitions originating from the field of education stand out from others due to their emphasis on identified needs and problems, established objectives, and the value attributed to innovation in light of its implementation outcomes. They observe a "high importance attributed in education to defining educational goals, as they enable to plan means and strategies for achieving educational goals [to achieve them]" (Morad, Ragonis and Barak, 2021, p. 11), as well as the significance of the value placed on "contribution to society by developing and improving learners' knowledge, to the pedagogy of teaching, or to the education system in general" (Morad, Ragonis and Barak, 2021, p. 11). While they recognize the importance of the value assigned to the outcomes of innovation, there is a notable lack of emphasis on the adoption component itself within definitions related to education.

We also consider it important to understand the terms related to innovation used in the reviewed articles, even when the concept itself is not explicitly defined. Of the 66 literature reviews analyzed, 57 (approximately 86.3%) do not clarify their understanding of innovation or related terminology. These terms are associated with the following themes: i. *innovation in education in general*, as exemplified by the phrase "*educational innovation*" (*e.g.*, Carrete-Marín and Domingo-Peñafiel, 2021); ii. *innovation in teaching methodologies and strategies*, involving the creation or modification of teaching and learning methods, as in "innovative pedagogical strategy" (*e.g.*, Gikandi, Morrow and Davis, 2011); iii. *curricular innovation*, reflected in expressions like "innovative curricula" (*e.g.*, Pepin, Biehler and Gueudet, 2021); iv. *innovation in technological resources*, concerning the use of innovative technologies, such as "emerging technologies" (*e.g.*, Neira, Salinas and Benito, 2017); and v. *aspects of innovation*, encompassing various elements of the innovation process, illustrated by terms like "innovativeness" (*e.g.*, Menold *et al*., 2016). It is important to note that our research highlights the expressions selected by the authors of the analyzed reviews, without delving into potential definitions ascribed by the primary sources of these reviews.

The conceptualizations identified enable a dialogue with the research by Tavares (2019), who conducted a study on explicit definitions of innovation in 23 scientific articles in the field of education, published between 1974 and 2017. The author proposed four categories to classify the innovation process based on its focus and attributed significance: 1. innovation as something inherently positive; 2. innovation as a synonym for educational change and reform; 3. innovation as the modification of curricular proposals; and 4. innovation as the alteration of customary educational practices within a social group (Tavares, 2019, p. 6).

Although our study focuses on a different level of analysis (literature reviews), we identified types of innovation that align with themes of curriculum and educational reform (*e.g.*, Gresnigt

et al., 2014; Aleixo, Silva and Silva Ramos, 2021), as well as the transformation of teaching practices (*e.g.*, Cheng, Hwang and Lai, 2020; Lencastre *et al*., 2020; Rodríguez-Jiménez, Pérez-Ochoa and Ulloa-Guerra, 2021). Conversely, the types of innovation identified through the (non-elaborated) expressions of innovation revealed a strong emphasis on technological resources, diverging from the framework proposed by Tavares (2019). In another point of convergence, we observed an *a priori* positive bias in some of the definitions identified in the sample. For Carr, Kendal, and Flynn (2016), behavioral innovations are defined as inherently useful; for Sharif (2019), López, Aroca, and Abellán (2020), and Rodríguez-Jiménez, Pérez-Ochoa, and Ulloa-Guerra (2021), innovation is consistently aimed at improving educational contexts. However, some definitions incorporate the process of evaluating innovation (Gresnigt *et al*., 2014; Morad, Ragonis and Barak, 2021), or omit any indication of an inherently positive value attributed to it (Morel *et al*., 2019; Moirano, Sánchez and Štěpánek, 2020; Castillo-Martínez and Ramírez-Montoya, 2021).

In alignment with the discussions presented in this section, we highlight two articles that offer theoretical and methodological insights, even though they do not provide a defined concept of innovation. Henderson and Corry (2021) explore the contributions of integrated technological innovation in the classroom to anxiety, introducing the term technostress. Menold *et al*. (2016), in turn, examined evaluation tools for innovativeness within the context of engineering, identifying 20 key characteristics related to individuals' propensity to adopt or resist innovations. While neither Menold *et al*. (2016) nor Henderson and Corry (2021) present an explicit definition of innovation, their approaches align with a broad notion of *change* within educational contexts and the derivative concept of *innovativeness*.

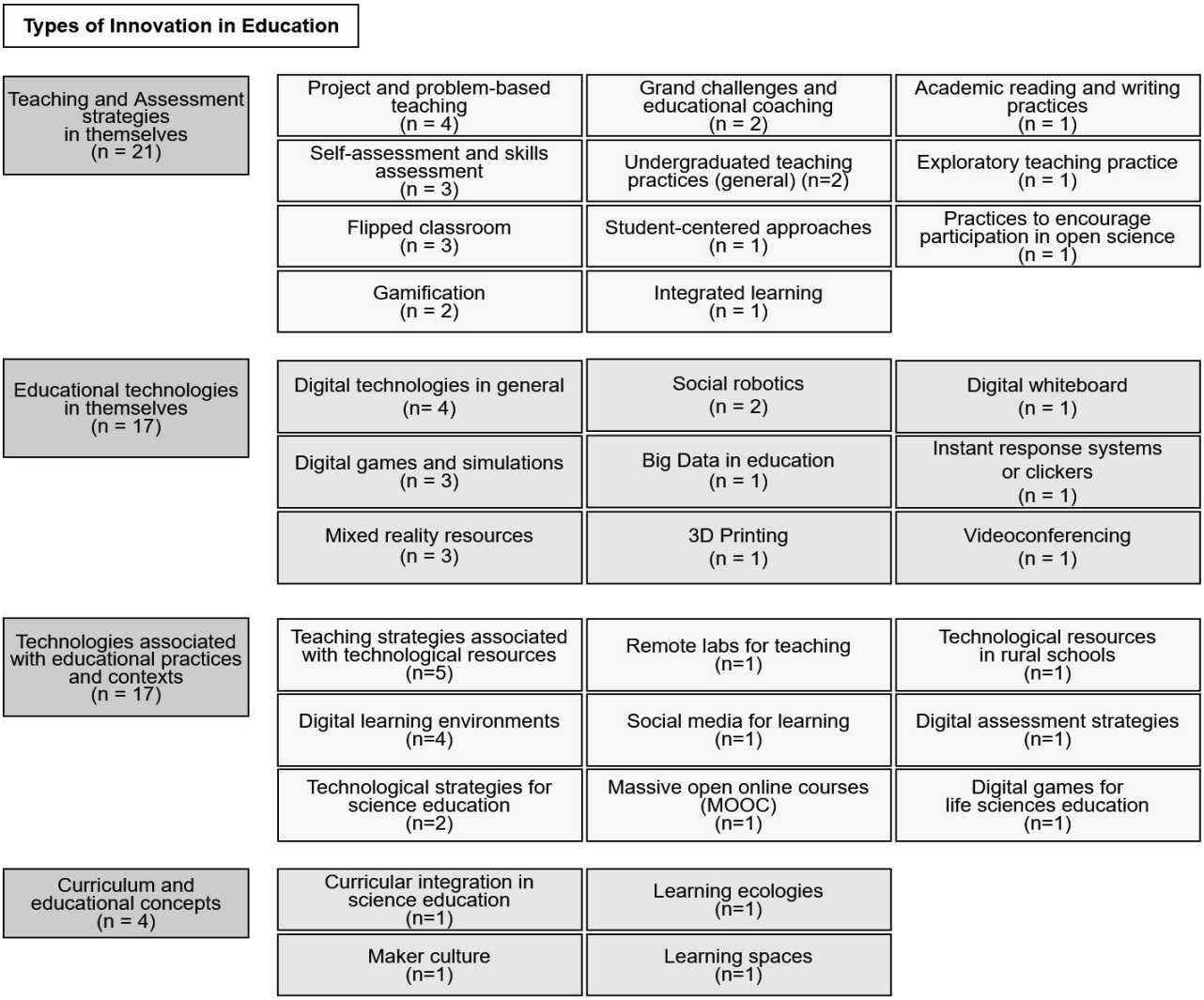
TYPES OF INNOVATION REVIEWED

The second step in understanding the innovations was to classify the types investigated in the reviewed studies. Of the total 66 articles, seven (approximately 10.6% of the total) do not focus on any specific innovation type and are categorized as theoretical-methodological discussions, and thus were included in the analysis of the previous section. The remaining 59 articles (approximately 89.3%) center on one or more specific innovation types within their review process, and these will be discussed below.

The majority of the *corpus* in our analysis consists of literature reviews on specific innovations. We determined that, of the 59 articles: 21 emphasize teaching and assessment strategies, considered innovative themselves; 17 focus on educational technologies, regarded as innovations on their own; 17 highlight teaching and assessment strategies in conjunction with the use of technologies, considered innovative as a collective set; and, finally, four articles with diverse innovations were grouped into another category, as they address types of innovation distinct from the previous ones. The elements discussed in these categorizations are summarized in Figure 2.

Approximately 31.8% (21 out of 66) of the selected works consider *teaching and assessment strategies* as central innovations in their reviews. For the authors, changes in strategies that characterize teaching or assessment are considered innovations themselves. Among the types of innovation addressed by the authors are: general teaching practices in undergraduate engineering (Pepin, Biehler and Gueudet, 2021) and social education (López, Aroca and Abellán, 2020). Authors also highlight student-centered teaching approaches (Santos, Figueiredo and Vieira, 2018), academic reading and writing practices (Castillo-Martínez and Ramírez-Montoya, 2021), and strategies to foster participation in Open Science (Ramírez-Montoya and García-Peñalvo, 2018). In addition to these strategies, specific active teaching methodologies were identified, such as: flipped classroom (Cheng, Hwang and Lai, 2020; Lencastre *et al*., 2020; Rodríguez-Jiménez, Pérez-Ochoa and Ulloa-Guerra, 2021); project-based learning (Puente, Eijck and Jochems, 2013; Hasni *et al*.,

Figure 2 – Summary of the types of educational innovation identified in the scope of the analysis conducted.



Source: the authors (2022).

2016) or problem-based learning (Hallinger and Bridges, 2017; Acton, 2019). Integrated content and language learning strategies (Goris, Denessen and Verhoeven, 2019), exploratory teaching practices (Hanks, 2019), and gamification of educational processes (Bozkurt and Durak, 2018; Palomino, 2021) are also highlighted. Additionally, some authors point to the mobilization of teaching through grand challenges (Nowell *et al*., 2020). Finally, competency assessment strategies (Cruz; Saunders-Smits and Groen, 2020; Markelz *et al*., 2020), self-assessment (Kambourova, González-Agudelo and Grisales-Franco, 2021), and educational coaching motivation methodologies (Loredo, Sierra-Arizmendiarrieta and Montero, 2019) were also identified.

Another 17 out of the 66 (25.8%) selected studies understand innovations as *educational technologies themselves*. These studies consider, in their investigations, educational resources of a technological nature or digital technologies in their aspects related to education as innovations. Some studies that are categorized as educational technologies (general) discuss: emerging technologies (Neira, Salinas and Benito, 2017); information and communication technologies (Colás Bravo, Pablos Pons and Ballesta Pagán, 2018); digital resources (Liu, Geertshuis and Grainger, 2020); and software technologies used in educational psychology research (Hadwin, Winne and

Nesbit, 2005). On the other hand, there are authors who emphasize specific digital and hardware technologies in their research: videoconferencing resources (Lawson *et al*., 2010); clickers or instant response systems (Liu *et al*., 2017); 3D printing (Novak *et al.*, 2021); digital whiteboards (Segovia and Romero-Varela, 2019); social robotics and robots for social interaction assistance (Papadopoulos *et al*., 2020; Perez, Burgos and Rodríguez, 2021); mixed reality environments and resources, including augmented or immersive virtual reality (Goff *et al.*, 2018; Pellas, Dengel and Christopoulos, 2020; Pellas, Kazanidis and Palaigeorgiou, 2020); educational digital games and simulations (Sánchez-Mena and Martí-Parreño, 2017; Vlachopoulos and Makri, 2017), among which serious games stand out (whose purpose is not limited to entertainment but aims to promote interactivity and digital competencies in educators) (Sandi Delgado and Sanz, 2019). Finally, one article emphasized the role of big data in education (Baig, Shuib and Yadegaridehkordi, 2020).

A third set of articles, consisting of 17 reviews (25.8%), is related to *technologies embedded in educational practices and contexts*. Unlike the previous ones, the authors consider technological resources as innovations only when they are integrated into pedagogical practices within educational contexts. Some authors investigate research that associates general teaching strategies (Lee, 2017; Davis *et al.*, 2018; Sykes, 2018; Valverde and Navarro, 2018; Burden *et al.*, 2019) and formative assessment (Gikandi, Morrow and Davis, 2011) that utilize digital tools and aspects in their execution. Similarly, some authors address the promotion of learning with the help of digital learning environments (Anthony *et al*., 2020; Whalley and Barbour, 2020; Alfoudari, Durugbo and Aldhmour, 2021; Chen *et al*., 2021) or digital games and remote labs for teaching science (Tho *et al*., 2017; Herrero Vázquez, Torralba-Burrial and Del Moral Pérez, 2020). Regarding collaborative learning, the use of social networks (Krouska; Troussas and Virvou, 2019) and massive open online courses (MOOCs) (Nortvig and Christiansen, 2017) has caught researchers' attention. Other innovative approaches using digital resources have been studied in rural school contexts (Carrete-Marin and Domingo-Peñafiel, 2021). Finally, specific strategies directed to students with autism spectrum disorder were also identified (Wainer and Ingersoll, 2011; Saladino, Marín Suelves and San Martín, 2019).

The remaining articles (6.1%) presented types of innovation related to curriculum issues and discussions on concepts and notions in education. These included the diffusion of concepts such as learning ecologies (Sangrá, Raffaghelli and Guitert-Catasús, 2019) and learning spaces (Durak and Cankaya, 2018). Curriculum issues were identified concerning topics such as innovation in disciplinary integration in science education (Gresnigt *et al.*, 2014) and the incorporation of maker culture in teaching (Aleixo, Silva and Silva Ramos, 2021).

The themes of the articles reviewed allow us to make some relevant considerations to understand what is considered innovation in the *corpus* of literature reviews analyzed. First, we developed a *characterization of the innovation process* based on the elements presented in the conceptualizations found in the reviewed articles. In this process, we highlight the importance of the convergence between perceived problems and needs within educational institutions, the educational objectives of pedagogical practice, and the planning for an intervention capable of generating transformations in the specific context. The teacher is considered important in the process but needs institutional support to innovate and to be on a professional development path.

Secondly, there is a *predominance of research focused on one or more specific innovations*, with a priority on conceptual and methodological aspects related to the theme of innovation. This seems to align with the predominant function of the literature review process in research: identifying works on a specific research topic and exploring research possibilities related to it. A notable absence is the use of conceptualizations of the innovation process that guide the development of literature reviews specifically focused on one or more innovations. It can be considered a rule that label expressions are used, especially in terms of innovations related to teaching practices and technological resources.

Aligned with this point, the *conception that both technologies and pedagogical practices are themselves considered innovations stands out*. These, therefore, offer two popular categories for understanding types of innovation in education, corroborating part of the innovation types resulting from the analysis of conceptualizations of the term, especially around practices, approaches, interventions, products, and tools. The result is consistent with the analysis of non-deepened expressions related to innovation, where *innovation in technological resources* and *innovation in teaching methodologies and strategies are notably prominent*. Beyond our *corpus* of analysis, this result aligns, in part, with the category of educational innovation as an alteration of teaching practices proposed by Tavares (2019), since technologies themselves are highlighted as innovations. The two categories point to a centrality in the teaching-learning processes in the classroom and, above all, in the role of teachers. This position carries the risk that the innovation process in educational contexts may be reduced to the simple transmission of technological resources or the organization of teaching and assessment strategies, and, further, that it may be understood as the sole responsibility of teachers.

In contrast, we highlight the presence of *conceptions of technologies as innovation only when they are integrated into educational practices and contexts*. Although less prominent than the items highlighted earlier, the identification of these elements suggests a contextual understanding of innovation. The reviews indicate that innovation involves teaching planning within a specific educational institution. In this way, they corroborate the notions present in our analysis of conceptualizations, particularly regarding the need to integrate innovation with educational objectives and overall pedagogical planning.

Finally, our analysis was characterized by the *low number of discussions centered on curricular innovations*, with only two articles focusing on the introduction of integration into the curricula of Natural Science Education (Gresnigt *et al.*, 2014) and the maker culture in the school environment (Aleixo, Silva and Silva Ramos, 2021). Our data and analyses do not support the emphasis on curricular change categories proposed by Tavares (2019). Despite the increasing focus on articles addressing *technological resources and teaching and evaluation strategies as innovations*, we find research in other areas related to the use of innovation in education to be highly relevant. Additionally, there are studies published between 2020 and 2021 that reference the COVID-19 pandemic and its potential impact on educational practices, driven by the abrupt transformations in social dynamics during this period. However, the review process in these works does not have the pandemic as its primary motivation.

WHAT ARE THE MAIN RESULTS RELATED TO THE PROCESS OF IMPLEMENTING INNOVATIONS PRESENT IN THE LITERATURE REVIEWS?

Next, we present an analysis of the impacts of the innovations reviewed and the factors that facilitate or challenge their adoption, according to the authors of the publications in the selected sample.

IMPACT OF THE ADOPTION OF EDUCATIONAL INNOVATIONS

Approximately 45.4% (30 out of 66) of the literature reviews analyzed highlight the main *consequences of implementing* innovations. Most authors report positive impacts, particularly related to student learning. This may indicate a possible pro-innovation bias (Rogers, 2003) toward the adoption of innovations in the classroom, similar to what was identified by Tavares (2019), although it is not the aim of this work to determine whether this bias originates from the authors of the reviews or from the studies they reviewed.

The positive impacts of adopting an innovation, as pointed out in the publications, were grouped into eight categories, as follows: i. benefits for pedagogical practice (n=9); ii. facilitation of assessment strategies for teachers and students (n=3); iii. openness to women and expansion of areas in scientific research (n=2); iv. improvement in the teacher-student relationship (n=8); (v) gains in student learning (n=21); vi. cultivation of perceptions and feelings of students (n=16); vii. development of student dispositions (n=14); viii. beneficial work experiences for students (n=7).

Regarding the benefits for pedagogical practice, the authors highlight that the implementation of innovations fosters: the development of positive teaching and learning beliefs (Colás Bravo, Pablos Pons and Ballesta Pagán, 2018); the formation of digital skills (Sandi Delgado and Sanz, 2019); greater contextualization of teaching (Hasni *et al.*, 2016); and inclusion (Lencastre *et al.*, 2020). In terms of positive assessment strategies for teachers and students, the authors emphasize the effectiveness (Sykes, 2018) and personalization (Gikandi, Morrow and Davis, 2011) of feedbacks and the development of self-assessment of learning (Colás Bravo, Pablos Pons and Ballesta Pagán, 2018; Gikandi, Morrow and Davis, 2011). For Hadwin, Winne, and Nesbit (2005) and Goff *et al*. (2018), in relation to category iii., the authors refer to the opening up of opportunities for women in science, technology, engineering and mathematics (STEM) research and the expansion of areas in scientific research, respectively. Among the aspects pointed out by the authors that improve the teacher-student relationship, we identify: trust between students and teachers (Loredo, Sierra-Arizmendiarrieta and Montero, 2019; Pepin, Biehler and Gueudet, 2021); student involvement in the learning process (Kambourova, González-Agudelo and Grisales-Franco, 2021); encouragement of student-teacher dialogue (Gikandi, Morrow and Davis, 2011); and the transformation of the roles assumed by teachers and students (Colás Bravo, Pablos Pons and Ballesta Pagán, 2018).

In categories v. to viii., the positive impact is linked to students and relates to the possibility of different and better learning experiences, work experiences, the cultivation of perceptions, beliefs, and feelings, or the development of their actions and dispositions. For example, Hasni *et al*. (2016) justify the adoption of science and technology teaching and learning based on projects as fostering the acquisition of knowledge and competencies, as well as increasing student motivation and interest. Regarding these categories of positive student impact, we identified the development of skills such as: *communicative* (*e.g.*, Nowell *et al.*, 2020); *problem-solving* (Hasni *et al.*, 2016); *interpersonal* (*e.g.*, Vlachopoulos and Makri, 2017); and *professional* (Palomino, 2021). Additionally, *students show an improvement in classroom performance* (*e.g.*, Goff *et al.*, 2018), *self-efficacy* (*e.g.*, Novak *et al.*, 2021), creativity (Santos, Figueiredo and Vieira, 2018), *motivation and interest in studies* (*e.g.*, Wainer and Ingersoll, 2011), *satisfaction* (*e.g.*, Papadopoulos *et al.*, 2020), and *collective work* (*e.g.*, Liu *et al.*, 2017).

Of the 30 articles reporting impacts, only two have a negative nature. Pellas, Dengel, and Christopoulos (2020) highlight an unwanted effect: the distraction caused by technologies, while Wainer and Ingersoll (2011) mention the difficulty of generalizing the expected learning outcomes and the ineffectiveness of the reviewed innovation. However, even when pointing out these issues, the authors remain supportive of the use of their respective innovations, encouraging further research to address the problems mentioned.

Davis *et al*. (2018), Goris, Denessen, and Verhoeven (2019), and Pellas, Dengel, and Christopoulos (2020) point out that some of the studies they reviewed did not identify learning gains when comparing the results of a control group with an experimental group, concerning 2D educational resources, integrated content and language learning, and MOOCs, respectively. Wainer and Ingersoll (2011) and Goris, Denessen, and Verhoeven (2019) highlight that the

learning outcomes of an innovation vary across different fields and educational levels. While not indicating negative impacts, Carrete-Marín and Domingo-Peñafiel (2021) also argue that the benefits are not guaranteed for those adopting an innovation; the results depend on the implementation and context.

In summary, the reviews generally highlight the positive impacts of adopting educational innovations, with a greater emphasis on the perceived outcomes in student relationships, emotions, and learning. The low number of null or negative impacts may represent a pro-innovation bias among the authors, similar to what Tavares (2019) pointed out. The authors of the reviewed works do not problematize the causes of these effects, so we cannot argue about this issue.

RELEVANT FACTORS FOR ADOPTING AN EDUCATIONAL INNOVATION

Through the qualitative analysis of the literature reviews conducted, we identified that 27 out of the 66 publications address challenges, conditions, or enablers for the adoption of an innovation. These elements, scattered throughout the texts of the documents, were organized into categories presented in Tables 1 to 5. Each figure represents an analyzed dimension, linking it to the relevant factors and the references citing each element. It is worth noting that each article may include one or more excerpts, thereby contributing to multiple relevant factors listed in the tables. A considerable variation in factors influencing the adoption of an innovation — either positively or negatively — was observed, amounting to a total of 38 factors.

Table 1 – Factors related to the educational institutional dimension.

Relevant factors	References
Infrastructure (n=12)	Alfoudari, Durugbo and Aldhmour (2021); Anthony *et al.* (2020); Carrete-Marin and Domingo-Penafiel (2021); Castillo-Martínez and Ramírez-Montoya (2021); Davis *et al.* (2018); Hasni *et al.* (2016); Lawson *et al.* (2010); Lee (2017); Papadopoulos *et al.* (2020); Pellas, Dengel and Christopoulos (2020); Pellas, Kazanidis and Palaigeorgiou (2020); Sánchez-Mena and Martí-Parreño (2017)
Financial support (n=10)	Aleixo, Silva and Silva Ramos (2021); Anthony *et al.* (2020; Davis *et al.* (2018; Gresnigt *et al.* (2014); Lawson *et al.* (2010); Liu, Geertshuis and Grainger (2020); Markelz *et al.* (2020); Nortvig and Christiansen (2017); Pellas, Dengel and Christopoulos (2020); Vlachopoulos and Makri (2017)
Pedagogical management (class scheduling, simplification of procedures, and time optimization) (n=8)	Castillo-Martínez and Ramírez-Montoya (2021); Davis *et al.* (2018); Hallinger and Bridges (2017); Hasni *et al.* (2016); Liu; Geertshuis; Grainger (2020); Sánchez-Mena and Martí-Parreño (2017); Santos, Figueiredo and Vieira (2018); Segovia and Romero-Varela (2019)
Teacher autonomy (n=2)	Anthony *et al*. (2020); Nortvig and Christiansen (2017)
Pedagogical and curricular limitations (n=1)	Nortvig and Christiansen (2017)
Collaboration in similar contexts (n=1)	Nortvig and Christiansen (2017)
Adoption of innovations by peers (n=1)	Sánchez-Mena and Martí-Parreño (2017)
Established rules and objectives (n=1)	Gresnigt *et al*. (2014)

Source: the authors (2022).

Table 2 – External factors influencing the adoption of innovations within the institution.

Relevant factors	References
School culture and public policies (n=7)	Aleixo, Silva and Silva Ramos (2021); Gresnigt *et al*. (2014); Hallinger and Bridges (2017); Hasni *et al*. (2016); Lee (2017); Nortvig and Christiansen (2017); Sánchez-Mena and Martí-Parreño (2017)
Recent academic research on the subject (n=6)	Aleixo, Silva and Silva Ramos (2021); Alfoudari, Durugbo and Aldhmour (2021); Davis *et al*. (2018); Liu, Geertshuis and Grainger (2020); Pepin, Biehler and Gueudet (2021); Ramírez-Montoya and García-Peñalvo (2018)
Cost-effective or emerging technologies (n=5)	Cheng, Hwang and Lai (2020); Lawson *et al*. (2010); Lee (2017); Pellas, Dengel and Christopoulos (2020); Neira, Salinas and De Benito (2017)
Teacher training program (n=5)	Castillo-Martínez and Ramírez-Montoya (2021); Lawson *et al*. (2010); Liu, Geertshuis and Grainger (2020); Markelz *et al*. (2020); Sánchez-Mena and Martí-Parreño (2017)
Teacher development and collaboration (n=4)	Aleixo, Silva and Silva Ramos (2021); Carrete-Marin and Domingo-Penafiel (2021); Liu, Geertshuis and Grainger (2020); Santos and Figueiredo; Vieira (2018)
Strategies for evaluating innovations (n=3)	Alfoudari, Durugbo and Aldhmour (2021); Davis *et al*. (2018); Pellas, Kazanidis and Palaigeorgiou (2020)
Support materials for the implementation of the innovation (n=3)	Alfoudari, Durugbo and Aldhmour (2021); Cheng, Hwang and Lai (2020); Liu, Geertshuis and Grainger (2020)
Assistance from researchers specializing in innovations (n=2)	Castillo-Martínez and Ramírez-Montoya (2021); Gresnigt *et al*. (2014)
External collaborations beyond the educational institution (n=1)	Whalley and Barbour (2020)
The innovation's ability to motivate students (n=1)	Sánchez-Mena and Martí-Parreño (2017)
Teaching career (n=1)	Anthony *et al*. (2020)

Source: the authors (2022).

When analyzing the factors within the dimension of the educational institution (Table 1), the prominence of authors citing the lack of infrastructure and financial support as barriers is striking. This outcome may be directly linked to the type of innovation investigated in the reviews, which predominantly relied on digital resources. Pedagogical management was identified both as an obstacle and as a facilitator — indicating that the more support institutions provide to teachers, the greater the likelihood of innovation. Although no barriers related to teacher autonomy or the alignment of institutional rules and objectives were identified, these aspects were highlighted as facilitators for the adoption of innovation.

Regarding the external dimensions involved in the adoption of innovations within institutions (Table 2), we emphasize the need for changes in school culture and public policies, particularly reducing the focus on standardized testing and the pressure to cover the entire curriculum, which often faces spatial and temporal constraints. Additionally, it is crucial to develop strategies for evaluating innovations to better support teachers in this endeavor.

Table 3 – Factors related to the individual dimension (teachers).

Relevant factors	References
Personal beliefs and feelings towards the innovation (n=7)	Anthony *et al*. (2020); Gresnigt *et al*. (2014); Hallinger and Bridges (2017); Liu, Geertshuis and Grainger (2020); Markelz *et al*. (2020); Santos, Figueiredo and Vieira (2018); Segovia and Romero-Varela (2019)
Difficulties in managing activities that involve and engage students (n=4)	Hallinger and Bridges (2017); Hasni *et al*. (2016); Papadopoulos *et al*. (2020); Pellas, Kazanidis and Palaigeorgiou (2020)
Prior knowledge of the innovation (n=4)	Anthony *et al*. (2020); Gresnigt *et al*. (2014); Pellas, Kazanidis and Palaigeorgiou (2020); Sánchez-Mena and Martí-Parreño (2017)
Perceived relative advantage of the innovation based on previous experiences (n=3)	Gresnigt *et al*. (2014); Liu, Geertshuis and Grainger (2020); Sánchez-Mena and Martí-Parreño (2017)
Motivation and openness to innovation (n=3)	Gresnigt *et al*. (2014); Sánchez-Mena and Martí-Parreño (2017); Segovia and Romero-Varela (2019)
Perspectives and attitudes towards teaching and learning (n=2)	Lencastre *et al*. (2020); Sánchez-Mena and Martí-Parreño (2017)
Pedagogical practices and teaching approaches that foster innovation (n=2)	Anthony *et al*. (2020); Liu, Geertshuis and Grainger (2020)
Difficulty in using innovative materials across different classes (n=1)	Pellas, Kazanidis and Palaigeorgiou (2020)
Expectations regarding students' educational performance (n=1)	Anthony *et al*. (2020)
Reflection on one's own classroom practice (n=1)	Segovia and Romero-Varela (2019)
Lack of creativity (n=1)	Segovia and Romero-Varela (2019)

Source: the authors (2022).

Table 4 – Factors related to the individual dimension (students).

Relevant factors	References
Engagement and collaboration in teaching activities (n=5)	Alfoudari, Durugbo and Aldhmour (2021); Anthony *et al*. (2020); Davis *et al*. (2018); Hasni *et al*. (2016); Lawson *et al*. (2010)
Negative perceptions of the innovation (n=1)	Lencastre *et al*. (2020)
Previous experiences with the innovation (n=1)	Anthony *et al*. (2020)
Anxiety regarding the new roles assumed in their teaching and learning process (n=1)	Hallinger and Bridges (2017)

Source: the authors (2022).

The availability of technologies and support materials, along with teacher training and collaboration, are key facilitators for adopting innovations. Although interconnected, we have separated teacher training programs and teacher development in Table 2, as the former refers to the technical training and testing of an innovation, while the latter focuses on professional development and peer support for innovation. Facilitating factors for innovation also include aspirations for career

Table 5 – Factors related to the interaction dimension.

Relevant factors	References
Teacher-Student (n=5)	Alfoudari, Durugbo and Aldhmour (2021); Davis *et al.* (2018); Hallinger and Bridges (2017); Lawson *et al.* (2010); Vlachopoulos and Makri (2017)
Teacher-Teacher (n=1)	Santos, Figueiredo and Vieira (2018)
Student-Student (n=1)	Vlachopoulos and Makri (2017)
Specialists-Institution-Teacher (n=1)	Anthony *et al.* (2020)

Source: the authors (2022).

advancement and external collaborations, such as partnerships between innovative educational institutions, community organizations, and governments.

Table 3 focuses on factors closely linked to teachers. In terms of teachers' beliefs and feelings, self-esteem, self-efficacy, and the satisfaction and desire for using innovation are viewed as facilitators, while anxiety presents a challenge. Motivation, creativity, and openness to innovation, along with perceptions, perspectives, and teaching practices aligned with innovations are also key factors that facilitate their implementation. These results agree with Gresnigt *et al.* (2014), who highlight that the process of innovation depends on the teacher's motivation to innovate and the sense of ownership of the innovation — that is, its appropriation by the adopting teachers. It is also important to consider the challenges of using the same materials across different classes and developing tasks that engage students in their learning process.

Regarding the factors that are closely linked to the teachers — such as their characteristics, attitudes, and professional relationships — we understand that establishing connections with academic researchers or innovative colleagues can be beneficial. These relationships can support both the preparation of activities and the classroom work, as well as foster new research conducted in various contexts, considering technological advancements and adopting a more neutral stance.

Regarding students (Table 4), three factors affecting the implementation of an innovation were identified related to student profiles, such as elements of student engagement and collaboration: the time and effort dedicated to the learning process; distractions caused by the innovation; and interest and motivation for study. Additionally, a negative perception of the innovation among students can serve as a barrier, and previous experience with innovative technologies is a crucial condition.

In the final category (Table 5), factors related to the interaction dimension emphasize the need for adjustments in the teacher-student and student-student dynamics within the classroom, placing the student at the center of the teaching and learning process. Additionally, strategies for innovation include teacher participation in teaching-focused communities and closer engagement between researchers, the institution, and the teacher.

In summary, the external dimensions related to those involved in the adoption of innovations within institutions and the educational institution itself garnered the most citations from the authors of the reviewed analyses. There is a clear need to invest efforts in adapting public policies and school culture, including in terms of institutional pedagogical management, to enable greater teacher flexibility for innovation in the classroom. We also recognize a need for new research in various fields of knowledge and teacher training program for utilizing innovations developed in academic settings (external to the innovating institution). Lastly, infrastructural and financial issues within educational institutions were identified as key factors for changing

teaching practices. Technological and financial concerns will be more critical for those teachers opting for a digital technological innovation in a less economically privileged context than for another choosing an active teaching strategy, for example.

CONCLUSION

This systematic review offers an approximation of the knowledge developed by the educational research community concerning the theme of innovation. To this end, we conducted an analysis of literature reviews, examining the conceptualizations of innovation within the educational sphere, exploring related expressions that authors had not deeply examined, the types of innovation reviewed, and the descriptions of impacts, along with the factors that either facilitated or hindered innovation in educational contexts.

Based on the analysis conducted, we underscore the necessity for researchers to explicitly articulate and critically examine their perspectives on innovation, rather than treating it as a naturalized term. We do not argue for the elimination of diverse interpretations, as such diversity enriches educational discourse; instead, we advocate for clarity in the definitions adopted, thereby avoiding the ambiguity inherent in the term and fostering the process of innovation.

The development of conceptualizations and models of innovation in education requires extensive, theoretically grounded research, which lies beyond the scope of this study but remains within the prospects of our ongoing investigations. Nevertheless, building upon the findings of this review, we believe that such efforts would be enriched by considering educational innovations as:

- A process, rather than standalone products or strategies, integrated into teaching practices as a whole over time — an aspect particularly crucial for overcoming technical rationality conceptions of innovation;
- Not inherently positive *a priori*, emphasizing the importance of evaluating the consequences of innovation, especially concerning educators and students;
- Potential responses, rather than absolute or definitive solutions, to the needs and challenges identified by those involved in educational processes, viewed not as ends in themselves but as means to address specific issues;
- Historically, socially, and culturally situated constructs, wherein the adoption of a teaching practice may be innovative in one context but not in another, depending on established practices, institutional culture, or prior experiences of educators;
- Transformations of varying magnitude, ranging from incremental innovations to large-scale disruptions within educational systems.

In addition to these factors, we highlight elements absent from the reviewed studies that we consider essential to the innovation process: the need to mobilize institutions collaboratively to facilitate internal innovation; fostering relationships among educators as a cornerstone for assessing the needs and consequences of innovation — for instance, through communities of practice in education; and conceptualizing innovation as a fusion of theory and practice, disentangled from a purely technical conception.

We acknowledge that this study has limitations, such as the predominance of foreign studies due to the selected database, leaving room for similar investigations focused on the Brazilian educational context. Nonetheless, our findings align with the pressing need to conceptualize the term innovation in the educational context with clarity, precision, and robust theoretical grounding to guide research in this field. This approach would foster a productive discussion on educational change, enabling dialogue across diverse perspectives without reducing the term to an empty label.

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References

ACTON, Renae. Mapping the evaluation of problem-oriented pedagogies in higher education: a systematic literature review. **Education Sciences**, v. 9, n. 4, p. 269, 2019. https://doi.org/10.3390/educsci9040269

ALEIXO, Adriana Alves; SILVA, Bento; RAMOS, Maria Altina Silva. Análisis del uso de la cultura maker en contextos educativos: una revisión sistemática de la literatura. **Educatio Siglo XXI**, v. 39, n. 2, p. 143-168, 2021. https://doi.org/10.6018/educatio.465991

ALFOUDARI, Aisha M.; DURUGBO, C.M.; ALDHMOUR, Fairouz M. Understanding socio-technological challenges of smart classrooms using a systematic review. **Computers & Education**, v. 173, n. 10, p. 104282, 2021. https://doi.org/10.1016/j.compedu.2021.104282

ANTHONY, Bokolo; KAMALUDIN, Adzhar; ROMLI, Awanis; RAFFEI, Anis Farihan Mat; NINCAREAN, Danakorn; EH PHON, A. L.; ABDULLAH, Aziman; MING, Gan Leong. Blended learning adoption and implementation in higher education: a theoretical and systematic review. **Technology, Knowledge and Learning**, v. 27, n. 2, p. 531-578, 2020. https://doi.org/10.1007/s10758-020-09477-z

BAIG, Maria Ijaz; SHUIB, Liyana; YADEGARIDEHKORDI, Elaheh. Big data in education: a state of the art, limitations, and future research directions. **International Journal of Educational Technology in Higher Education**, v. 17, n. 1, p. 44, 2020. https://doi.org/10.1186/s41239-020-00223-0

BOZKURT, Aras; DURAK, Gürhan. A systematic review of gamification research: in pursuit of homo ludens. **International Journal of Game-Based Learning**, v. 8, n. 3, p. 15-33, 2018. https://doi.org/10.4018/ijgbl.2018070102

BURDEN, Kevin; KEARNEY, Matthew; SCHUCK, Sandra; HALL, Tony. Investigating the use of innovative mobile pedagogies for school-aged students: A systematic literature review. **Computers & Education**, v. 138, n. 2, p. 83-100, 2019. https://doi.org/10.1016/j.compedu.2019.04.008

CARR, Kayleigh; KENDAL, Rachel L.; FLYNN, Emma G. Eureka!: what is innovation, how does it develop, and who does it? **Child Development**, v. 87, n. 5, p. 1505-1519, 2016. https://doi.org/10.1111/cdev.12549

CARRETE-MARIN, Núria; DOMINGO-PEÑAFIEL, L. Los recursos tecnológicos en las aulas multigrado de la escuela rural: Una revisión sistemática. **Revista Brasileira de Educação do Campo**, p. 1-31, 2021. https://doi.org/10.20873/uft.rbec.e13452

CASTILLO-MARTÍNEZ, Isolda Margarita; RAMÍREZ-MONTOYA, María Soledad. Research competencies to develop academic reading and writing: a systematic literature review. **Frontiers in Education**, v. 5, p. 576961, 2021. https://doi.org/10.3389/feduc.2020.576961

CHEN, Xieling; ZOU, Di; XIE, Haoran; WANG, Fu Lee. Past, present, and future of smart learning: a topic-based bibliometric analysis. **International Journal of Educational Technology in Higher Education**, v. 18, n. 1, p. 2, 2021. https://doi.org/10.1186/s41239-020-00239-6

CHENG, Shu-Chen; HWANG, Gwo-Jen; LAI, Chiu-Lin. Critical research advancements of flipped learning: a review of the top 100 highly cited papers. **Interactive Learning Environments**, p. 1-17, 2020. https://doi.org/10.1080/10494820.2020.1765395

COLÁS BRAVO, María Pilar; PABLOS PONS, Juan de; BALLESTA PAGÁN, Javier. Incidencia de las TIC en la enseñanza en el sistema educativo español: una revisión de la investigación. **Revista de Educación a Distancia**, n. 56, 2018.

COOPER, Harris; HEDGES, Larry ; VALENTINE, Jeff. **The handbook of research synthesis and meta-analysis**. New York: Russell Sage Foundation, 2009.

CRUZ, Mariana Leandro; SAUNDERS-SMITS, Gillian Nicola; GROEN, Pim. Evaluation of competency methods in engineering education: a systematic review. **European Journal of Engineering Education**, v. 45, n. 5, p. 729-757, 2020. https://doi.org/10.1080/03043797.2019.1671810

DAVIS, Dan; CHEN, Guanliang; HAUFF, Claudia; HOUBEN, Geert-Jan. Activating learning at scale: A review of innovations in online learning strategies. **Computers & Education**, v. 125, p. 327-344, 2018. https://doi.org/10.1016/j.compedu.2018.05.019

DURAK, Gurhan; CANKAYA, Serkan. The Current State of The Art in Learning Spaces: A Systematic Review Study. **International Journal of Emerging Technologies in Learning (iJET)**, v. 13, n. 11, p. 208, 2018. https://doi.org/10.3991/ijet.v13i11.9247

FULLAN, Michael. **O significado da mudança educacional**. Tradução: Ronaldo Cataldo Costa. 4. ed. [S.l.]: Penso, 2009.

GIKANDI, Joyce W.; MORROW, D.; DAVIS, N.E. Online formative assessment in higher education: A review of the literature. **Computers & Education**, v. 57, n. 4, p. 2333-2351, 2011. https://doi.org/10.1016/j.compedu.2011.06.004

GOFF, Eric E.; MULVEY, Kelly Lynn; IRVIN, Matthew J.; HARTSTONE-ROSE, Adam. Applications of Augmented Reality in Informal Science Learning Sites: a Review. **Journal of Science Education and Technology**, v. 27, n. 5, p. 433-447, 2018. https://doi.org/10.1007/s10956-018-9734-4

GORIS, José; DENESSEN, E.; VERHOEVEN, L. Effects of content and language integrated learning in Europe A systematic review of longitudinal experimental studies. **European Educational Research Journal**, v. 18, n. 6, p. 675-698, 2019. https://doi.org/10.1177/1474904119872426

GRESNIGT, Rens; TACONIS, Ruurd; VAN KEULEN, Hanno; GRAVEMEIJER, Koeno; BAARTMAN, L.K.J. Promoting science and technology in primary education: a review of integrated curricula. **Studies in Science Education**, v. 50, n. 1, p. 47-84, 2014. https://doi.org/10.1080/03057267.2013.877694

HADWIN, Allyson F; WINNE, Philip H; NESBIT, John C. Roles for software technologies in advancing research and theory in educational psychology. **British Journal of Educational Psychology**, v. 75, n. 1, p. 1-24, 2005. https://doi.org/10.1348/000709904x19263

HALLINGER, Philip; BRIDGES, Edwin M. A systematic review of research on the use of problem-based learning in the preparation and development of school leaders. **Educational Administration Quarterly**, v. 53, n. 2, p. 255-288, 2017. https://doi.org/10.1177/0013161X16659347

HANKS, Judith. From research-as-practice to exploratory practice-as-research in language teaching and beyond. **Language Teaching**, v. 52, n. 2, p. 143-187, 2019. https://doi.org/10.1017/S0261444819000016

HASNI, Abdelkrim; BOUSADRA, Fatima; BELLETÊTE, Vincent; BENABDALLAH, Ahmed; NICOLE, Marie-Claude; DUMAIS, Nancy. Trends in research on project-based science and technology teaching and learning at K–12 levels: a systematic review. **Studies in Science Education**, v. 52, n. 2, p. 199-231, 2016. https://doi.org/10.1080/03057267.2016.1226573

HENDERSON, Jessa; CORRY, Michael.Teacher anxiety and technology change: a review of the literature. **Technology, Pedagogy and Education**, v. 30, n. 4, p. 573-587, 2021. https://doi.org/10.1080/1475939X.2021.1931426

HERRERO VÁZQUEZ, Mónica; TORRALBA-BURRIAL, Antonio; DEL MORAL PÉREZ, Esther. Revisión de investigaciones sobre el uso de juegos digitales en la enseñanza de las ciencias de la vida en Primaria y Secundaria. **Enseñanza de las Ciencias. Revista de investigación y experiencias didácticas**, v. 38, n. 2, p. 103-119, 2020. https://doi.org/10.5565/rev/ensciencias.2806

KAMBOUROVA, Miglena; GONZÁLEZ-AGUDELO, Elvía María; GRISALES-FRANCO, Lina María. La autoevaluación del estudiante universitario: revisión de la literatura. **Teoría de la Educación. Revista Interuniversitaria**, v. 33, n. 2, p. 217-264, 2021. https://doi.org/10.14201/teri.23672

KROUSKA, Akrivi; TROUSSAS, Christos; VIRVOU, Maria. SN-Learning: An exploratory study beyond e-learning and evaluation of its applications using EV-SNL framework. **Journal of Computer Assisted Learning**, v. 35, p. 168-177, 2019. https://doi.org/10.1111/jcal.12330

LAWSON, Tony; COMBER, Chris; GAGE, Jenny; CULLUM-HANSHAW, Adrian. Images of the future for education? Videoconferencing: a literature review. **Technology, Pedagogy and Education**, v. 19, n. 3, p. 295-314, 2010. https://doi.org/10.1080/1475939X.2010.513761

LEE, Kyungmee. Rethinking the accessibility of online higher education: A historical review. **The Internet and Higher Education**, v. 33, n. 1, p. 15-23, 2017. https://doi.org/10.1016/j.iheduc.2017.01.001

LENCASTRE, José Alberto; MORGADO, José Carlos; FREIRES, Thiago; BENTO, Marco. A systematic review on the flipped classroom model as a promoter of curriculum innovation. **International Journal of Instruction**, v. 13, n. 4, p. 575-592, 2020. https://doi.org/10.29333/iji.2020.13436a

LIU, Cui; CHEN, Sufen; CHI, Chi; CHIEN, Kuei-Pin; LIU, Yuzhen; CHOU, Te-Lien. The effects of clickers with different teaching strategies. **Journal of Educational Computing Research**, v. 55, n. 5, p. 603-628, 2017. https://doi.org/10.1177/073563311667421

LIU, Qian; GEERTSHUIS, Susan; GRAINGER, Rebecca. Understanding academics' adoption of learning technologies: A systematic review. **Computers & Education**, v. 151, p. 103857, 2020. https://doi.org/10.1016/j.compedu.2020.103857

LÓPEZ, Silvia Martínez de Miguel; AROCA, Juan Antonio Salmerón; ABELLÁN, Pedro Moreno. Innovación educativa en el grado de Educación Social de las universidades españolas: una revisión sistemática. **Educar**, v. 56, n. 2, p. 491-508, 2020.

LOREDO, Eva Ramos; SIERRA-ARIZMENDIARRIETA, Beatriz; MONTERO, Cristina Roces. Ámbitos de aplicación del Coaching educativo: una revisión bibliográfica del periodo 2013-17. **Educatio Siglo XXI**, v. 37, n. 2, p. 223-244, 2019. https://doi.org/10.6018/educatio.387091

MARKELZ, Andrew; SCHEELER, Mary Catherine; RICCOMINI, Paul J; TAYLOR, Jonte C. A systematic review of tactile prompting in teacher education. **Teacher Education and Special Education: The Journal of the Teacher Education Division of the Council for Exceptional Children**, v. 43, n. 4, p. 296-313, 2020. https://doi.org/10.1177/0888406419877500

MENOLD, Jessica; JABLOKOW, Kathryn; FERGUSON, Daniel M.; PURZER, Senay; OHLAND, Matthew W. The characteristics of engineering innovativeness: a cognitive mapping and review of instruments. **International Journal of Engineering Education**, v. 32, n. 1(A), p. 64-83, 2016.

MOIRANO, Regina; SÁNCHEZ, Marisa Analía; ŠTĚPÁNEK, Libor. Creative interdisciplinary collaboration: A systematic literature review. **Thinking Skills and Creativity**, v. 35, p. 100626, 2020. https://doi.org/10.1016/j.tsc.2019.100626

MORAD, Sigal; RAGONIS, Noa; BARAK, Miri. An integrative conceptual model of innovation and innovative thinking based on a synthesis of a literature review. **Thinking Skills and Creativity**, v. 40, p. 100824, 2021. https://doi.org/10.1016/j.tsc.2021.100824

MOREL, Richard Paquin; COBURN, Cynthia; CATTERSON, Amy Koehler; HIGGS, Jennifer. The multiple meanings of scale: implications for researchers and practitioners. **Educational Researcher**, v. 48, n. 6, p. 369-377, 2019. https://doi.org/10.3102/0013189X19860531

NEIRA, Edgar Andres Sosa; SALINAS, Jesus; BENITO, Barbara De. Emerging technologies (ETs) in education: a systematic review of the literature published between 2006 and 2016. **International Journal of Emerging Technologies in Learning**, v. 12, n. 5, p. 128, 2017. https://doi.org/10.3991/ijet.v12i05.6939

NORTVIG, Anne-Mette; CHRISTIANSEN, René B. Institutional collaboration on MOOCs in education — a literature review. **The International Review of Research in Open and Distributed Learning**, v. 18, n. 6, 2017. https://doi.org/10.19173/irrodl.v18i6.3110

NOVAK, Elena; BRANNON, Megan; LIBREA-CARDEN, Mila Rosa Latina; HAAS, Amy. A systematic review of empirical research on learning with 3D printing technology. **Journal of Computer Assisted Learning**, v. 37, n. 5, p. 1455-1478, 2021. https://doi.org/10.1111/jcal.12585

NOWELL, Lorelli; DHINGRA, Swati; ANDREWS, Kimberley; GOSPODINOV, Julia; LIU, Cathy; HAYDEN, K. Alix. Grand challenges as educational innovations in higher education: a scoping review of the literature. **Education Research International**, v. 2020, p. 1-39, 2020. https://doi.org/10.1155/2020/6653575

PALOMINO, Mª del Carmen Pegalajar. Implicaciones de la gamificación en Educación Superior: una revisión sistemática sobre la percepción del estudiante. **Revista de Investigación Educativa**, v. 39, n. 1, p. 169-188, 2021. https://doi.org/10.6018/rie.419481

PAPADOPOULOS, Irena; LAZZARINO, Runa; MIAH, Syed; WEAVER, Tim; THOMAS, Bernadette; KOULOUGLIOTI, Christina. A systematic review of the literature regarding socially assistive robots in pre-tertiary education. **Computers & Education**, v. 155, p. 103924, 2020. https://doi.org/10.1016/j.compedu.2020.103924

PELLAS, Nikolaos; DENGEL, Andreas; CHRISTOPOULOS, Athanasios. A scoping review of immersive virtual reality in STEM education. **IEEE Transactions on Learning Technologies**, v. 13, n. 4, p. 748-761, 2020. https://doi.org/10.1109/TLT.2020.3019405

PELLAS, Nikolaos; KAZANIDIS, Ioannis; PALAIGEORGIOU, George. A systematic literature review of mixed reality environments in K-12 education. **Education and Information Technologies**, v. 25, n. 4, p. 2481-2520, 2020. https://doi.org/10.1007/s10639-019-10076-4

PEPIN, Birgit; BIEHLER, Rolf; GUEUDET, Ghislaine. Mathematics in Engineering Education: a review of the recent literature with a view towards innovative practices. **International Journal of Research in Undergraduate Mathematics Education**, v. 7, n. 2, p. 163-188, 2021. https://doi.org/10.1007/s40753-021-00139-8

PEREZ, Itsaso Arocena; BURGOS, Asier Huegun; RODRÍGUEZ, Itziar Rekalde. La robótica como herramienta didáctica para personas con desórdenes en el espectro del autismo: una revisión sistemática. **Etic@net. Revista científica electrónica de Educación y Comunicación en la Sociedad del Conocimiento**, v. 21, n. 1, p. 51-82, 2021. https://doi.org/10.30827/eticanet.v21i1.18137

PUENTE, Sonia Maria Gomez; VAN EIJCK, Michiel; JOCHEMS, Wim M.G. A sampled literature review of design-based learning approaches: a search for key characteristics. **International Journal of Technology and Design Education**, v. 23, n. 3, p. 717-732, 2013. https://doi.org/10.1007/s10798-012-9212-x

RAMÍREZ-MONTOYA, María-Soledad; GARCÍA-PEÑALVO, Francisco José. Co-creation and open innovation: Systematic literature review. **Comunicar**, v. 26, n. 54, p. 9-18, 2018. https://doi.org/10.3916/C54-2018-01

RODRÍGUEZ JIMÉNEZ, Franmis José; PÉREZ-OCHOa, María Elena; ULLOA-GUERRA, Óscar. Aula invertida y su impacto en el rendimiento académico: una revisión sistematizada del período 2015-2020. **EDMETIC**, v. 10, n. 2, p. 1-25, 2021. https://doi.org/10.21071/edmetic.v10i2.13240

ROGERS, Everett M. **Diffusion of innovations**. . ed. New York: Free Press, 2003.

SALADINO, Melchiorre; MARÍN SUELVES, Diana; SAN MARTÍN, Ángel. Aprendizaje mediado por tecnología en alumnado con TEA. Una revisión bibliográfica. **Etic@net. Revista científica electrónica de Educación y Comunicación en la Sociedad del Conocimiento**, v. 19, n. 1, p. 1-25, 2019. https://doi.org/10.30827/eticanet.v19i1.11858

SÁNCHEZ-MENA, Antonio; MARTÍ-PARREÑO, José. Teachers' acceptance of educational video games: a comprehensive literature review. **Journal of e-Learning and Knowledge Society**, v. 13, n. 2, 2017. https://doi.org/10.20368/1971-8829/139

SANDI DELGADO, Juan Carlos; and SANZ, Cecilia Verónica. Juegos serios para potenciar la adquisición de competencias digitales en la formación del profesorado. **Revista Educación**, v. 44, n. 1, p. 454-471, 2019. https://doi.org/10.15517/revedu.v44i1.37228

SANGRÁ, Albert; RAFFAGHELLI, Juliana Elisa; GUITERT-CATASÚS, Montse. Learning ecologies through a lens: Ontological, methodological and applicative issues. A systematic review of the literature. **British Journal of Educational Technology**, v. 50, n. 4, p. 1619-1638, 2019. https://doi.org/10.1111/bjet.12795

SANTOS, Júlia; FIGUEIREDO, Amélia Simões; VIEIRA, Margarida. Innovative pedagogical practices in higher education: An integrative literature review. **Nurse Education Today**, v. 72, p. 12-17, 2018. https://doi.org/10.1016/j.nedt.2018.10.003

SEGOVIA, Miriam M. Rojas; ROMERO-VARELA, Douglas Y. Revisión de la influencia de la motivación docente en el empleo de las pizarras digitales interactivas. **Propósitos y Representaciones**, v. 7, n. 2, p. 516-535, 2019. https://doi.org/10.20511/pyr2019.v7n2.228

SHARIF, Rukhsar. The relations between acculturation and creativity and innovation in higher education: A systematic literature review. **Educational Research Review**, v. 28, p. 100287, 2019. https://doi.org/10.1016/j.edurev.2019.100287

SYKES, Julie M. Interlanguage pragmatics, curricular innovation, and digital technologies. **CALICO Journal**, v. 35, n. 2, p. 120-141, 2018. https://doi.org/10.1558/cj.36175

TAVARES, Fernando Gomes de Oliveira. O conceito de inovação em educação: uma revisão necessária. **Educação (UFSM)**, v. 44, 2019. https://doi.org/10.5902/1984644432311

THO, Siew Wei; YEUNG, Yau Yuen; WEI, Rui; WING ANDREW, Chan Ka; SO, Winnie Wing Mui. A Systematic Review of Remote Laboratory Work in Science Education with the Support of Visualizing its Structure through the HistCite and CiteSpace Software. **International Journal of Science and Mathematics Education**, v. 15, n. 7, p. 1217-1236, 2017. https://doi.org/10.1007/s10763-016-9740-z

VALVERDE, Rosario Isabel Herrada; NAVARRO, Raúl Baños. Aprendizaje cooperativo a través de las nuevas tecnologías: Una revisión. **@tic revista d'innovació educativa**, n. 20, p. 16, 2018. https://doi.org/10.7203/attic.20.11266

VLACHOPOULOS, Dimitrios; MAKRI, Agoritsa. The effect of games and simulations on higher education: a systematic literature review. **International Journal of Educational Technology in Higher Education**, v. 14, n. 1, p. 22, 2017. https://doi.org/10.1186/s41239-017-0062-1

WAINER, Allison L.; INGERSOLL, Brooke R. The use of innovative computer technology for teaching social communication to individuals with autism spectrum disorders. **Research in Autism Spectrum Disorders**, v. 5, n. 1, p. 96-107, 2011. https://doi.org/10.1016/j.rasd.2010.08.002

WHALLEY, Rachel; BARBOUR, Michael K. Collaboration and virtual learning in new zealand rural primary schools: a review of the literature. **Turkish Online Journal of Distance Education**, v. 21, n. 2, p. 102-125, 2020. https://doi.org/10.17718/tojde.727983

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