Multimodal Technologies and Interaction

Systematic Review

From Consumption to Co-Creation: A Systematic Review of Six Levels of AI-Enhanced Creative Engagement in Education

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Abstract

As AI systems become more integrated into society, the relationship between humans and AI is shifting from simple automation to co-creative collaboration. This evolution is particularly important in education, where human intuition and imagination can combine with AI's computational power to enable innovative forms of learning and teaching. This study is grounded in the #ppAI6 model, a framework that describes six levels of creative engagement with AI in educational contexts, ranging from passive consumption to active, participatory co-creation of knowledge. The model highlights progression from initial interactions with AI tools to transformative educational experiences that involve deep collaboration between humans and AI. In this study, we explore how educators and learners can engage in deeper, more transformative interactions with AI technologies. The #ppAI6 model categorizes these levels of engagement as follows: level 1 involves passive consumption of AI-generated content, while level 6 represents expansive, participatory co-creation of knowledge. This model provides a lens through which we investigate how educational tools and practices can move beyond basic interactions to foster higher-order creativity. We conducted a systematic literature review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting the levels of creative engagement with AI tools in education. This review synthesizes existing literature on various levels of engagement, such as interactive consumption through Intelligent Tutoring Systems (ITS), and shifts focus to the exploration and design of higher-order forms of creative engagement. The findings highlight varied levels of engagement across both learners and educators. For learners, a total of four studies were found at level 2 (interactive consumption). Two studies were found that looked at level 3 (individual content creation). Four studies focused on collaborative content creation at level 4. No studies were observed at level 5, and only one study was found at level 6. These findings show a lack of development in AI tools for more creative involvement. For teachers, AI tools mainly support levels two and three, facilitating personalized content creation and performance analysis with limited examples of higher-level creative engagement and indicating areas for improvement in supportive collaborative teaching practices. The review found that two studies focused on level 2 (interactive consumption) for teachers. In addition, four studies were identified at level 3 (individual content creation). Only one study was found at level 5 (participatory co-creation), and no studies were found at level 6. In practical terms, the review suggests that educators need professional development focused on building AI literacy, enabling them to recognize and leverage the different levels of creative engagement that AI tools offer.

Keywords: creativity; education; creative pedagogy; artificial intelligence; #ppAI6; creative engagement

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Correction Statement: This article has been republished with a minor change. The change does not affect the scientific content of the article and further details are available within the backmatter of the website version of this article.

1. Introduction

The rapid integration of artificial intelligence (AI) into various sectors of society is reshaping not only how we live and work but also how we learn and teach. Within education, this evolution offers both challenges and unprecedented opportunities [1]. In particular, the domains of AI and creativity are of central importance, as creativity is now widely recognized as a core 21st-century competence for learners and educators alike. However, the rapid proliferation of AI tools has produced fragmented evidence regarding their role in fostering creativity. AI is no longer confined to automating routine processes but can be used as a collaborator, capable of augmenting human creativity, supporting problem-solving, and fostering new forms of knowledge production. The use of AI in education also raises concerns in relation to the potential dependency resulting from cognitive offloading to AI systems [2]. The potential of AI to support creativity requires consideration of both the creative learning processes that AI tools can enhance and how AI may also promote "dark creativity" [3]. In the context of education, this necessitates examining how the use of AI could potentially hinder learning processes. This study conducts a systematic literature review, synthesizing existing knowledge on the various levels of creative engagement with AI in education.

Despite the increasing integration of AI into educational contexts, there is still a limited understanding of how AI tools foster creativity across different levels of engagement. Existing studies often concentrate on personalization, automation, or assessment, leaving a gap in systematic knowledge about AI's capacity to enable collaborative and co-creative learning. While creativity and 21st-century skills are frequently emphasized in educational frameworks [1,4], the study of how AI can support creative processes across a continuum from passive to transformative engagement is not yet developed. To address this gap, this study applies the #ppAI6 framework to conduct a systematic review of the literature, with the aim of identifying how AI tools support creative engagement for both learners and teachers. Specifically, the review is guided by the following research questions (RQ):

RQ1. How do learners engage creatively with AI tools across the six levels of the #ppAI6 framework?

RQ2. How do teachers engage creatively with AI tools across the six levels of the #ppAI6 framework?

By articulating these questions, the study clarifies its contribution to ongoing debates in AI and creativity in education, offering both theoretical lens and practical insights for educators, developers, and researchers.

2. Creativity for 21st Century Education

In the context of 21st-century education, creative pedagogy is required rather than optional. Competency frameworks around the world increasingly recognize creativity as a core skill, both at the individual and collective levels [4,5]. Creativity involves a dynamic interplay of divergent and convergent thinking, employed across a wide range of activities, from artistic expression to complex problem-solving. This recognition has led to creativity being featured prominently in frameworks for 21st-century skills, reinforcing the need for pedagogical approaches that actively foster creative thinking and action. While creativity is a central focus of this review, it is closely interwoven with other transversal competencies that define 21st-century education. Critical thinking, for example, underpins the evaluation of AI-generated outputs and ensures that learners develop the capacity to question, interpret, and refine information provided by AI systems [6–8]. Problem-solving is another essential skill, often fostered in AI-supported learning environments such as *Intelligent Tutoring Systems* and game-based simulations, where learners must iteratively test solutions and adapt strategies [9,10]. Collaboration is increasingly highlighted in studies of

AI-enhanced education, as digital platforms and co-creation tools enable learners to work collectively with peers and AI to address complex tasks [11,12]. Also, digital literacy has become fundamental in ensuring that both learners and educators can navigate AI tools effectively and ethically [6,9].

There is a growing consensus within the learning sciences on the importance of integrating innovative, creative pedagogy across all levels of education [5]. This pedagogical shift has become even more critical with the rapid integration of artificial intelligence (AI) tools into educational contexts. Since the release of tools like *ChatGPT* in 2022 (GPT-3.5), AI's role in education has expanded beyond automation and efficiency to include complex cognitive and creative support. As these generative AI tools gain traction among teachers, learners, and caregivers, they raise new ecological, ethical, and pedagogical considerations [6].

Within this evolving landscape, AI is not just a technological addition. AI has the potential to be a partner in the learning process and in some creative learning tasks [1]. Its applications range from assisting with routine tasks to enabling new forms of creative expression and co-creation. AI tools can support varying levels of creative engagement, a form of learning that combines cognitive challenge with active participation, where learners are not passive recipients of information but creative agents capable of producing original ideas or artifacts. At one end of the creative engagement spectrum lies the passive use of AI, where learners consume content generated autonomously by AI with minimal interaction. At the other end, AI becomes a collaborative partner in co-creativity, enhancing the learner's creative process through interactive and participatory approaches. This paper begins with a comparative analysis of human and artificial creativity, followed by the presentation of a framework that outlines six levels of creative engagement with AI in education, offering a pathway for integrating AI tools meaningfully within creative pedagogy.

3. Human Creativity and Artificial Creativity

Creativity has long been celebrated as a uniquely human cognitive ability. According to Henriksen and colleagues [7], critical thinking is viewed as the cornerstone of 21st-century education due to its transversal nature, which spans across disciplines and facilitates complex problem-solving. This form of critical thinking, intrinsic to human cognition, requires individuals to engage in rational reasoning within specific cultural frameworks and interpersonal relationships [8]. In contrast, contemporary artificial intelligence (AI) systems, although capable of producing creative outputs, necessitate human intervention to address inherent biases present in the datasets they are trained on. These biases can influence the knowledge generated by AI, potentially deviating from human values, including human rights and equality. Therefore, cultivating artificial creativity where AI generates valuable and innovative ideas requires not only advanced technological design but also careful human supervision. This supervision ensures that AI's creative outputs align with ethical standards and does not perpetuate harmful biases, such as those related to gender, race, or other forms of discrimination. As Dietrich and Haider [9] note, human creativity is characterized by the ability to produce both innovative and practical ideas, with a critical process of evaluation shaped by socio-cultural norms and values. This process is also essential in the realm of artificial creativity.

For AI to generate truly innovative and beneficial outcomes, it is not enough for AI models to simply produce novel ideas; these outputs must be subjected to critical human evaluation to ensure their relevance, fairness, and ethical soundness. This critical oversight is essential for guiding AI toward positive, human-centric creativity, where the technology's potential to enhance human creative practices is maximized, while minimizing risks of harm or bias. Thus, the development of artificial creativity, much like human creativity, requires ongoing human involvement, specifically through the lens of critical thinking, to avoid unintended negative consequences and ensure that the outcomes serve the broader goals of equity and social good.

4. From Passive to Participatory Creative Engagement in AIED

Creative engagement in educational tasks spans a broad spectrum, with learners often transitioning from passive to active modes of involvement. In traditional, lecture-based activities, learners typically engage in passive listening, absorbing information from the instructor without active participation. In contrast, the active learning paradigm, which has gained widespread adoption in recent decades, emphasizes learner-centered approaches that prioritize cognitive engagement during learning activities. This approach encourages students to engage deeply with content, fostering critical thinking and problem-solving. However, mere cognitive engagement may not be sufficient to develop the 21st-century skills necessary for success in today's rapidly evolving world. To foster creativity, it is essential that learners engage not only cognitively but also creatively with tasks, leading to the creation of unique, valuable, and innovative outputs [9]. Creative engagement requires an active, participatory approach to learning, where the learner's involvement transcends passive reception and moves toward a more hands-on, co-creative process. Importantly, the support for creative engagement can either emerge from within the AI tools themselves or from external pedagogical strategies that guide learners' creativity. For example, the *Cognitively based Assessments as, for, and of Learning* (CBAL) initiative [10] is designed to assist teachers by providing prompts that facilitate various forms of external regulation of learners' activities. In this system, creative learning activity is not conducted within the tool itself, but rather, teachers use the system to guide and structure tasks that stimulate creative thought in learners. This highlights the potential for AI to act as a supportive tool for creative teaching, even when the task itself takes place outside of the system. Similarly, Learning Management Systems (LMS), such as those integrated with the Massive Open Online Course (MOOC) [13,14], can accommodate diverse learner models and activities. These systems enable the application of learning analytics [13], which track and analyze student progress, facilitating intelligent tutoring and providing real-time insights into learner behaviors, such as purchasing patterns. These features hold promise for enhancing creative teaching by enabling instructors to regulate and respond to students' creative engagement more effectively. Without a pedagogical framework that actively emphasizes creativity, such systems risk failing to cultivate genuine creative engagement in both teachers and learners. The degree of creative engagement exhibited by teachers or learners in any given task is shaped by how AI tools are utilized. For instance, Intelligent Tutoring Systems (ITS), Automated Writing Evaluation (AWE), and certain forms of Digital Game-Based Learning (DGBL) are specifically designed to adjust dynamically to students' interactions. In these contexts, the nature of the learning activities the students engage in determines the level of creative involvement. As a result, the impact of AI tools on creativity depends on their integration and application within the educational process.

5. Six Levels of AI-Enhanced Creative Engagement in Education

Building upon the spectrum of creative engagement in educational tasks, this section introduces the #ppAI6 framework to differentiate the six distinct levels of creative engagement when AI tools are integrated into the learning process [15]. While earlier discussions emphasized the range from passive consumption to more active, participatory forms of learning, the #ppAI6 framework further elaborates on the increasing depth of creative engagement that learners can experience through AI-driven educational tools.

The six levels outlined in the #ppAI6 model reflect a continuum from basic interactions, where learners merely receive or navigate AI-generated content, to more advanced forms of co-creation.

Figure 1 illustrates six distinct levels of creative engagement using artificial intelligence (AI) tools in educational settings, ranging from basic to advanced stages. These levels correspond to varying degrees of creative involvement that a learner may demonstrate during the socio-cognitive process of learning:

- Level 1: *Passive Consumer*. In this stage, the learner is a passive recipient of AI-generated content, engaging minimally with the material. The learner simply consumes information produced by the AI system without any active participation in the creative process.
- Level 2: *Interactive Consumer*. The learner interacts with an AI system that provides feedback and influences the progression of activities based on the learner's actions. However, the learner does not engage in creative tasks per se; instead, they navigate the system's feedback based on predefined structures, following instructions from the AI without contributing novel ideas.
- Level 3: *Individual Content Creation*. The learner moves beyond simple interaction to engage in innovative problem-solving, where they generate new ideas or solutions that are not predetermined by the AI system. This stage reflects a deeper form of cognitive engagement, as learners produce original outputs.
- Level 4: *Collaborative Content Creation*. At this level, a small group of learners collaborates on creative activities, producing various ideas or solutions collectively. While AI may assist or facilitate the process, the outputs are not dictated by the system, highlighting a shift towards cooperative, peer-driven creativity.
- Level 5: *Participatory Knowledge Co-Creation*. A group of learners engages in a creative participatory activity, where they address complex, challenging problems. In this stage, learners not only collaborate within their own group but also interact with external collaborators, further expanding their collective creative efforts. This level emphasizes community involvement and the integration of diverse perspectives.
- Level 6: *Expansive Learning supported by AI*. In this advanced level, participants' agency is enhanced or transformed through AI-supported formative interventions. AI tools help identify contradictions in complex problems, generate concepts or artifacts to regulate conflicting stimuli, and foster collective agency and action. The AI system can be used to model activity systems and simulate new actions, enabling expansive visualization of potential solutions and facilitating a deeper level of problem-solving.

Figure 1. Six Levels of AI-Enhanced Creative Engagement (#ppAI6).

The six levels of the Passive-Participatory model of creative engagement in AI tools (#ppAI6) are presented as a hierarchical continuum as illustrated in Figure 1, progressing from minimal creative involvement (level 1: Passive Consumer) toward higher-order co-creative processes (level 6: Expansive Learning supported by AI). However, in practice, these levels are not strictly linear. Learners and educators may oscillate between levels depending on task design, tool affordances, and pedagogical context. For example, an activity may combine individual content creation (level 3) with collaborative content creation (level 4), illustrating that levels can overlap or co-occur rather than being mutually exclusive.

The #ppAI6 model bears similarities to Chi and Wylie's ICAP framework [16] at the initial level, which they classify as "passive." However, the levels from three to five are drawn from the #ppAI6 model [17]. In the first two levels, learners are not directly involved in creative activities: at level 1, they passively consume AI-generated content; in level 2, they interact with the AI system, which adjusts based on learner input, yet still offers limited creative engagement. In level 2, the AI's feedback and the learner's actions are based on a predefined task model and learner model embedded within the system. This level often employs AI technologies like Intelligent Tutoring Systems (ITS), where learners follow a structured "programmed instruction" approach, engaging with the system's feedback rather than generating new ideas. At level 3, learners begin to demonstrate innovative content creation, producing outputs relevant to the educational context. Progression to levels 4 and 5 represents a shift toward co-creation and collaboration, where learners contribute collectively to creative endeavors. This collaborative process helps learners better understand the creation and development of new ideas. level 5 sees learners apply their creative work to real-world problems [18], promoting community involvement and focusing on local problem-solving [11]. In level 6, AI can be used not only for knowledge co-creation in participatory contexts but also to transform human practices, while conceptualizing differently and developing the participants' agency, as a shared collaborative process between generative AI tools and human agents. At this sixth level, AI is integrated into the creation of critical knowledge and aims to develop agency and transform human practices [17].

While the ICAP framework [16] places interactivity at the core of cognitive engagement, the #ppAI6 model emphasizes participatory knowledge co-creation as the key differentiator. This level involves learners in socio-constructivist, project-based activities, where they actively engage in identifying, understanding, and addressing challenges in their local or learning communities. This collaborative approach aims to tackle real-world problems [11], thereby positioning learners as agents of change.

6. Research Objectives

This study aims to explore the role of artificial intelligence (AI) tools in fostering creative engagement in educational settings, focusing on both learners and teachers. The research objectives are framed around the #ppAI6 framework, which conceptualizes six levels of creative engagement with AI tools in education, ranging from passive to deep participatory processes. The primary goal is to identify and understand how AI tools influence creative engagement for both learners (Research Objective 1, RO1) and teachers (RO2), assessing their respective roles within this continuum.

6.1. Research Objective 1 (RO1): Identification of Learners' Creative Engagement

The first objective of this research (RO1) is to investigate how learners engage with AI tools at different levels of creative involvement, as outlined in the #ppAI6 framework. For this objective, the study aims to categorize and analyze the ways in which learners exhibit creative engagement, ranging from passive consumption of AI-generated content to active co-creation and participatory knowledge generation. By examining the various studies in scientific literature, we aim to determine how AI tools either constrain or expand creative involvement in educational tasks, and how this engagement aligns with the levels proposed in the #ppAI6 model [17]. This objective will provide valuable insights into the potential of AI tools to enhance or limit learners' creative agency within educational contexts.

6.2. Research Objective 2 (RO2): Identification of Teachers' Creative Engagement

The second objective (RO2) focuses on identifying how teachers' creative engagement is supported or influenced by AI tools, as seen through the #ppAI6 framework. Unlike learners, who are the primary users of AI tools in most educational contexts, teachers play a crucial role in designing and facilitating creative tasks. This objective seeks to explore how AI tools support teachers in their creative processes, from the generation of new instructional content to the adaptation of teaching strategies based on real-time learning analytics. By understanding the levels of creative engagement exhibited by teachers when using AI tools, we aim to uncover how AI can empower teachers to be more innovative in their pedagogical approaches, ultimately fostering a more dynamic and creative learning environment for students.

7. Method

We conducted a systematic literature review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [19] for reporting the learners' creative engagement with AI tools (RO1) and the teachers' creative engagement (RO2). The objective of the review was to identify and analyze empirical studies that examine the use of AI tools in educational contexts, with a specific focus on how these tools influence creative engagement as conceptualized by the #ppAI6 framework. The following query was used for the search: ("creative pedagogy" OR "creative learning") AND ("artificial intelligence" OR "AI" OR "generative AI" OR "genAI") AND ("education" OR "educational technology"). The review focused on papers published in the *ScienceDirect* database in the period 2020–2025, permitting the identification of 95 research articles. Our choice of the *ScienceDirect* database was based on its high academic reputation and wide range of peer-reviewed papers in computer science, education, and cross-disciplinary studies. *ScienceDirect* hosts over 1,500 peer-reviewed journals, many of which are indexed in *Scopus*, *Web of Science*, *PubMed*, and *Google Scholar*. Only peer-reviewed papers are in the *ScienceDirect* database. We completed this initial search by also selecting the papers meeting the criteria published in the *International Journal of Artificial Intelligence in Education* (IJAIED). This journal was selected due to its centrality in the field and its relevance to both AI and education research. The IJAIED search permitted the identification of 59 additional papers.

All articles were screened for eligibility based on the inclusion criteria: empirical focus, educational context, and relevance to either learners' or teachers' engagement with AI. Studies that solely presented technical AI models without pedagogical or creative elements, purely participatory studies without AI or creativity components, and editorials were excluded. As illustrated in Figure 2, a total of 91 papers were excluded based on these criteria. The final dataset comprised 63 papers that met the inclusion criteria and were subsequently analyzed according to the #ppAI6 engagement levels for both learners and teachers.

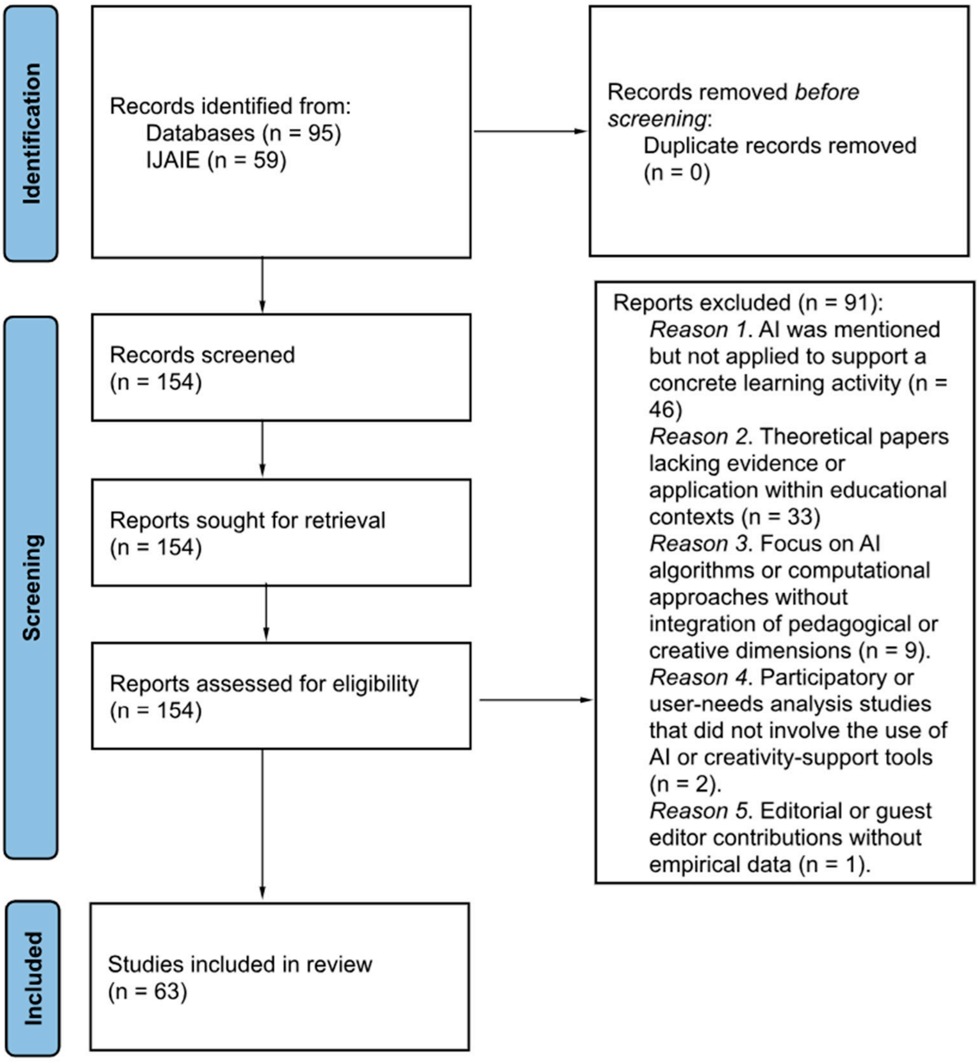

Figure 2. Overview of the research process guided by the PRISMA framework.

This review follows the PRISMA 2020 guidelines [19]. The search strategy, including Boolean queries, search fields, language restrictions, and the search date, is reported in Appendix A. The screening and coding process was conducted independently by two reviewers. Both reviewers applied the inclusion and exclusion criteria to the initial set of records and coded each included study according to the six levels of the #ppAI6 framework.

To determine the level of creative engagement for each study, we applied the operational definitions of the six levels in the #ppAI6 framework [17]. Each article was analyzed for the type of task, the role of the AI tool, and the degree of agency demonstrated by learners and/or teachers. For instance, studies where participants only received adaptive feedback from AI without contributing novel content were classified as level 2 (interactive consumption), whereas studies reporting learner or teacher generation of original outputs were coded as level 3 (individual content creation). Collaborative activities supported by AI were classified at level 4, and so forth. The coding was conducted through repeated readings of each study and the application of explicit inclusion criteria derived from the #ppAI6 model.

Discrepancies in coding were discussed and resolved through clarification of the operational definitions of each level, ensuring a shared understanding and consistent application of the framework. Data extraction follows the operational definitions of the six levels of the #ppAI6 framework. No formal risk-of-bias tool is applied, given the heterogeneity of study designs. Transparency is ensured by reporting inclusion/exclusion criteria, coding decisions, and synthesis methods. The synthesis follows a narrative approach organized by the #ppAI6 framework.

8. Results

We introduce the results of the research objectives 1 (RO1) and 2 (RO2) corresponding to the learners' creative engagement and the teachers' creative engagement, respectively. A review of 63 research articles revealed creative engagement with AI tools in 12 studies focused on learners, seven studies on teachers, and four studies on both groups. Figure 3 illustrates the distribution of these studies across the six levels of the #ppAI6 framework.

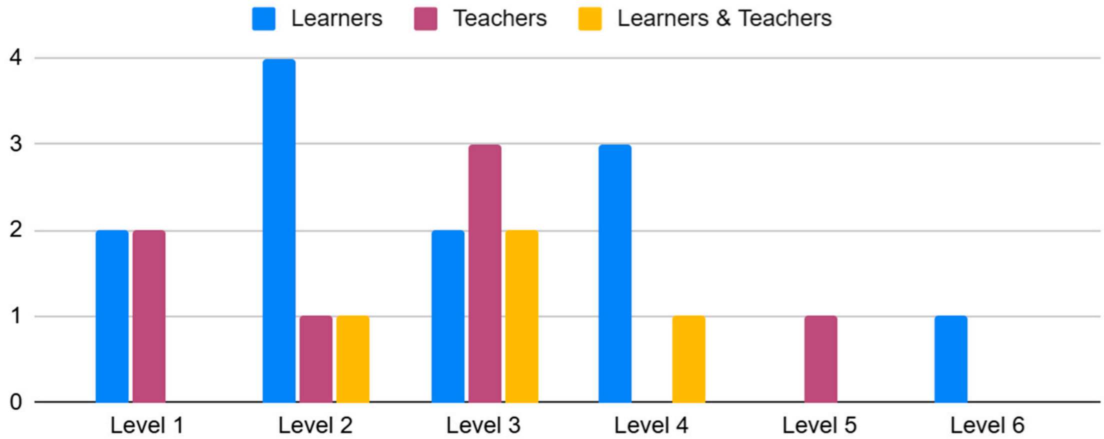

Figure 3. Six Levels of AI-Enhanced Creative Engagement (#ppAI6) for learners (RO1) and teachers (RO2).

8.1. Learner Engagement (RO1)

For learners, the most frequent level of creative engagement was level 2, with four studies identified. A total of two studies were at level 1, and two studies were at level 3. Three studies were found at level 4. Only one study was found at level 6, while no studies were found at level 5.

8.2. Teacher Engagement (RO2)

For teachers, the most common level of creative engagement was level 3, with three studies. Two studies were found at level 1, and one study was found at level 2. A single study was also identified at level 5, but none were found at levels 4 and 6.

8.3. Combined Learner and Teacher Engagement (RO1 ∩ RO2)

Four studies were found that addressed creative engagement for both learners and teachers. Of these, two studies were at level 3, and one study was at level 2. One study was found at level 4, while no studies were identified at levels 1, 5, or 6 for both groups.

Table 1 provides a structured summary of the findings from the review, detailing the contributions, targeted users, and corresponding levels of AI-enhanced creative engagement identified in the selected studies.

Table 1. Summarized papers related to AI-enhanced creative engagement in education (#ppAI6 model).

Citation	Contributions and AI Solution	#ppAI6 Level	Focus	Educational Level
Lawson et al. [20]	Emotional engagement analysis with AI-generated virtual instructors	Level 1	Learners	Higher
Uto et al. [21]	Writing process analysis using a Hidden Markov Model based on keystroke data	Level 1	Teachers	Secondary and Higher
Maniktala et al. [22]	Encouraging hint usage via interface changes in the *Assertions* ITS	Level 2	Learners	Higher
Tacoma et al. [23]	Adaptive tutoring using *DME*, providing looped feedback for statistics learning	Level 2	Learners	Higher
de Chiusole et al. [24]	Supporting self-regulated learning and instruction adaptation with *Stat-Knowlab*	Level 2	Learners and Teachers	Higher
Smith et al. [25]	Using ML to predict beneficial student interventions for teachers	Level 2	Teachers	Higher
Wilson et al. [26]	Automated feedback and scoring in writing education with *MiWRITE*	Level 3	Learners and Teachers	Primary
Zapata-Rivera [10]	AI-based assessment support with *CBAL* and *English-ABLE* tools	Level 3	Learners and Teachers	Secondary and Higher
Kurdi et al. [27]	Content creation via AI-based *Automated Question Generation* (AQG)	Level 3	Teachers	Mostly Higher
Arruarte et al. [28]	Performance-based assessment design using *TEA* visual learning analytics	Level 3	Teachers	Higher
Lajoie [12]	Collaborative problem-solving with *BioWorld* and *HOWARD* platforms	Level 4	Learners and Teachers	Higher
Yannier et al. [29]	STEM learning through a mixed-reality AI system in *NoRILLA*	Level 4	Learners	Primary
Yusri et al. [30]	Game-based collaborative privacy education via the *Teens Online* platform	Level 4	Learners	Secondary
Habib et al. [31]	Student perspectives on creative pedagogy with AI	Level 1	Learners	Higher
Wang [32]	Impact of teacher workload on creative pedagogy use	Level 1	Teachers	Secondary
Mei et al. [33]	ChatGPT's effect on creativity in writing tasks	Level 2	Learners	Higher
Zhang & Xu [34]	AI use and student self-efficacy in task completion	Level 2	Learners	Higher
Tsao & Nogues [35]	AI literacy via creative storytelling	Level 3	Learners	Higher
Charles et al. [36]	Generative AI in multimedia project assessments	Level 3	Learners	Higher
Stephenson [37]	Drama pedagogy and collective creativity with AI	Level 4	Learners	Primary
El-Sayed et al. [38]	AI competence and creativity in nurse education	Level 3	Teachers	Higher
Yuwono et al. [39]	AI co-creation with innovation champions	Level 5	Teachers	Primary and secondary
Lin & Chang [40]	Design thinking and AI-enhanced creativity	Level 6	Learners	Higher

Some studies are literature reviews and consider multiple levels of education, such as Kurdi et al. [27], which mainly focused on the use of Automated Question Generation (AQG) in higher education but included some papers studying AQG in primary or secondary education. In the case of Yuwono et al. [39], the focus is on K12 educators, which includes primary and secondary education. In the context of language learning, the studies by Zapata-Rivera [10] and Uto et al. [21] scope from secondary to higher education.

RO1. Identification of Learners' Creative Engagement

The analysis of 63 studies revealed that most creative engagement instances were centered on the learner's perspective (n = 12), with only five instances where AI tools supported teachers' or instructors' creative engagement. Notably, three studies corresponding to the AI tools *BioWorld & HOWARD Platform* [12], *MiWRITE* [26], and *English-ABLE* and *CBAL* [10], highlight how AI tools can support both learners and instructors in their creative engagement processes. Regarding passive engagement, where learners are not directly involved in creative activities, Lawson et al. [20] explored how students emotionally responded to animated instructors during presentations. A total of four studies were found at the "interactive consumption" level (level 2), where learners use AI tools to assist with predefined learning activities, and the AI system adjusts to the learner's needs. Examples include AI tools like *Assertions* [22] and *DME* [23]. Intelligent Tutoring Systems (ITS), often recognized under various names such as "Intelligent Learning Tool", are prominent at this level. For example, de Chiusole et al. [24] observed that *Stat-Knowlab*, an ITS designed to teach statistics, helped both students and teachers in creative ways by improving self-regulated learning and enabling teachers to adapt content to match students' levels. At the individual content creation level (level 3), two studies focused on learners. The AI tools *BioWorld & HOWARD Platform*, *MiWRITE*, and *CBAL* systems [10,26] also support both groups in their creative processes. Collaborative content creation (level 4) was observed in four studies. At this fourth level, the AI tool *NoRILLA* [29] employed Augmented Reality (AR) to support STEM education, and the AI tool *HOWARD Platform* [12] enabled real-time collaboration between learners and instructors in problem-based learning environments. Additionally, the study on the AI tool *Teens Online* [30] also demonstrated collaborative engagement in a game-based learning context. We do not observe studies at the fifth level, but one study at the sixth level [40].

RO2. Identification of Teachers' Creative Engagement

Seven studies specifically addressed creative teaching. In Kurdi et al. [27], the use of Automated Question Generation (AQG) with AI helped instructors generate diverse quizzes, representing a third level of creative engagement as teachers created new content through the system. In Uto et al. [21], machine learning was employed to analyze writing patterns, providing valuable feedback for instructors. This process helped instructors increase their creative involvement by improving assessment strategies, positioning the study at level 1 of creative participation. Smith et al. [25] investigated how Machine Learning (ML) could be used to predict which students would benefit from interventions, thus enhancing creative engagement in the classroom. This was recognized as level 2, where instructors use AI-driven insights to adapt their teaching strategies. The study of *TEA* [28], an AI tool leveraging visual learning analytics, demonstrated level 3 creative engagement, where instructors used the tool's analyses to improve assessments and interventions. We observe only one study at the fifth level [39] but no studies at the sixth level.

9. Discussion

Our objective has been to investigate the intersection of human and artificial creativity within educational contexts, focusing on how AI tools can support and enhance creative engagement for both learners and teachers. Creativity, a fundamental cognitive process, involves the generation of novel and valuable ideas, solutions, or artifacts. In educational settings, fostering creativity is essential for developing critical 21st-century skills. By applying the #ppAI6 framework, which identifies six levels of creative engagement with AI, this study examines how AI tools facilitate varying degrees of creative involvement.

The findings highlight the varied levels of creative engagement with AI tools in education, focusing on both learners and teachers. For learners (RO1), four studies are centered on the interactive consumption level (level 2), where AI tools adapt to learners' inputs, offering personalized feedback but not requiring creative input. At level 3 (individual content creation), AI tools like *Physics Playground* [41] allow learners to generate original solutions, reflecting deeper cognitive engagement. Few studies observed collaborative engagement (level 4), like *NoRILLA* [29], but AI's role in collaborative, problem-solving environments remains underexplored. Additionally, participatory knowledge co-creation (level 5) was not observed, suggesting a gap in AI tool development. For teachers (RO2), AI tools, such as Automated Question Generation [27] and *TEA* [28], support creative engagement at levels 2 and 3, helping teachers create personalized content and analyze student performance. However, higher-level creative engagement (e.g., collaborative or participatory creativity) is less common, indicating room for improvement in AI's role in supporting co-creative teaching practices.

AI has the potential to foster creative engagement, especially for learners in more structured, feedback-driven tasks. For teachers, AI aids in instructional design and adaptive feedback but could further support collaborative teaching strategies. To build on these findings, future empirical studies should consider testing whether interventions specifically designed to promote levels 5 and 6 of creative engagement led to deeper creative outcomes for both learners and educators. Such studies could provide valuable insights into the effectiveness of co-creative AI tools and inform future developments in AI-enhanced education.

The findings of this study align with existing research on the current limitations of AI tools in educational settings. Prior studies have emphasized the dominance of lower levels of AI engagement in educational applications, particularly those focusing on personalized feedback and adaptive learning. These studies highlight that while AI can support learners in more structured environments, the potential for collaborative and co-creative engagement remains largely underexplored, which is consistent with the results presented in this study. The underrepresentation of level 4 (collaborative engagement), level 5 (participatory co-creation), and level 6 (transformative learning) further confirms the gap in AI development towards more dynamic, interactive learning experiences.

The observed prevalence of lower levels of engagement, particularly level 2 (interactive consumption), can be attributed to the current state of AI development in education. Most AI tools currently available are primarily designed to function as adaptive systems that respond to learner inputs but do not facilitate deeper creative engagement, such as collaboration or co-creation. This aligns with the work of Hwang and Cheng [42], who emphasize that AI's role in education remains largely limited to tasks like personalization and automation, leaving minimal space for more expansive, creative activities. Moreover, the absence of AI tools that promote higher levels of engagement may reflect an insufficient understanding of the pedagogical frameworks necessary to support these creative processes. The limited observations of levels 5 (participatory co-creation) and 6 (expansive learning) of creative engagement in the reviewed studies could reflect both the current limitations of educational AI tools and constraints in research design. Most existing tools continue to emphasize personalized learning and feedback, offering limited support for collaborative or co-creative practices.

10. Conclusions

These findings reinforce the view that the current generation of AI tools in education is primarily designed for adaptive support and content delivery, rather than for fostering higher-order creative collaboration. The predominance of lower-level engagements highlights a mismatch between the potential of AI as a partner in co-creativity and its actual use in practice. While personalization and automation provide valuable scaffolding for both learners and teachers, they remain insufficient for cultivating the collective knowledge-building and expansive learning processes envisioned at the higher levels of the #ppAI6 framework. The underrepresentation of levels 5 and 6 also suggests broader systemic challenges. On the technological side, few AI tools have been designed with explicit co-creative or participatory functions. On the pedagogical side, educators may lack the training and professional development needed to harness AI for more complex forms of creative engagement. Addressing these gaps requires not only technical innovation in AI design but also pedagogical strategies that position AI as a collaborator rather than a mere assistant.

While the review provides a comprehensive account of current practices, it is important to acknowledge certain limitations that frame the scope of the methodology and the findings. A limitation of this study is the deliberate focus on a restricted number of databases, namely ScienceDirect and the International Journal of Artificial Intelligence in Education (IJAIED). This choice was made to ensure a deep, focused analysis of a highly relevant and reputable body of literature. The selection of ScienceDirect was based on its academic reputation and wide range of peer-reviewed papers, while the IJAIED was included for its centrality to the field of AI and education research. Future research should expand its scope to investigate how advancing creative AI uses can be effectively leveraged across a wider range of educational settings and disciplines in the coming years. Some elements of PRISMA 2020 compliance remain partial. The absence of protocol registration, the lack of a formal risk-of-bias assessment, and limited consideration of publication bias reduce the reproducibility of this review. These aspects represent methodological limitations and indicate directions for strengthening future systematic reviews in this field.

The scarcity of studies situated at levels 5 and 6 of the #ppAI6 framework is also a limitation of the present review. This underrepresentation limited our ability to provide concrete examples of participatory and transformative creative engagement with AI. At the same time, this gap points to a significant opportunity for future research: the design and empirical testing of AI tools and pedagogical interventions that actively support knowledge co-creation and transformative learning practices. Future research should also expand the range of sources to include central education and technology databases as well as gray literature, apply validated instruments for measuring creativity and transversal skills, and conduct comparative analyses of #ppAI6 levels across diverse educational contexts. Such studies will help validate and extend the applicability of the framework.

The practical implications of these findings are significant. For educators, the gap between the current capabilities of AI tools and the desired higher level of creative engagement underscores the need for targeted professional development. This development should focus on equipping educators with the skills to integrate AI tools into more collaborative and co-creative learning environments, fostering deeper cognitive and creative engagement. Table 2 outlines specific educator actions and AI tool features corresponding to each level of the #ppAI6 model, offering a practical guide for integrating AI tools into educational practices.

Beyond the pedagogical implications, the findings must also be considered considering ethical concerns regarding the use of AI in education. Algorithmic bias, explainability, and accessibility difficulties highlight the risks of reinforcing inequalities or embedding discriminatory patterns into educational practices [43]. Expanding research on the creative uses of AI through the #ppAI6 framework requires not only technical and pedagogical innovation but also explicit attention to issues of transparency, accountability, and equity.

Table 2. Educator Actions and AI Tool Features Across #ppAI6 Engagement Levels.

#ppAI6 Level	Description	Educator Actions	AI Tool Features
Level 1: Passive Consumption	Learners passively consume AI-generated content without interaction.	Provide pre-designed AI-generated materials (e.g., lectures, quizzes).	Content delivery systems (e.g., automated text, videos proposed by a recommendation system).
Level 2: Interactive Consumption	AI tools respond to learners' inputs, offering personalized feedback without requiring creative input.	Assign tasks that adapt to individual learner needs and monitor progress.	Intelligent tutoring systems (ITS).
Level 3: Individual Content Creation	Learners create content individually, with AI supporting their creative processes.	Encourage independent creation (e.g., writing, design tasks) and use AI to help refine or guide ideas.	AI tools that provide suggestions, templates, or critiques for content creation (e.g., text generation, creative problem-solving tools).
Level 4: Collaborative Engagement	Learners collaborate with AI and peers to solve problems or complete projects.	Facilitate group work, co-design learning tasks, and encourage peer interaction.	Co-creation tools that allow learners to create AI outcomes in collaboration in a small group.
Level 5: Participatory Co-Creation	Learners and AI collaboratively create new knowledge or solutions.	Encourage learners to work with AI to generate new ideas, develop projects, and explore solutions.	Co-creation tools that allow learners to create AI outcomes in collaboration with different actors.
Level 6: Transformative Learning	AI tools enable learners and educators to co-create knowledge in dynamic, innovative ways, fostering transformative learning experiences.	Redesign the learning environment to encourage innovation, facilitate critical thinking, and support ongoing reflection.	AI systems that adapt to learner feedback in real-time, integrating peer, teacher, and AI perspectives for continuous co-creation and learning.

The study points to the necessity of advancing both research and practice toward more creative uses of AI in education. While AI holds significant potential to personalize learning and enhance instructional design, its capacity to co-create knowledge with both learners and teachers remains underexplored. Future research should aim to investigate how AI can be leveraged to facilitate more participatory forms of engagement, wherein learners and teachers collaborate to design, solve, and innovate. Furthermore, the development of AI tools that support higher levels of engagement will require a shift in both their design and implementation. These tools must be aligned with pedagogical principles that prioritize creativity, collaboration, and critical thinking, ensuring that AI's full potential in education is realized.

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Abbreviations

The following abbreviations are used in this manuscript:

AI	Artificial Intelligence
AIED	Artificial Intelligence in Education
AQG	Automated Question Generation
AWE	Automated Writing Evaluation
DGBL	Digital Game-Based Learning
ITS	Intelligent Tutoring Systems
LMS	Learning Management Systems
ML	Machine Learning
MOOC	Massive Open Online Course

Appendix A. Search Strategy

The search strategy is reported according to PRISMA-S recommendations. The Boolean queries were tailored to each database, with specifications of fields, language restrictions, and the date of the last search.

Appendix A.1. Databases Searched

- ScienceDirect (Elsevier)
- International Journal of Artificial Intelligence in Education (IJAIED)

Appendix A.2. Search Fields

- ScienceDirect: Title, abstract, and keywords
- IJAIED: Title, abstract, and full text (due to database search interface constraints)

Appendix A.3. Search Strings

The Boolean query was: ("artificial intelligence" OR "AI") AND (education OR learning OR teaching OR pedagogy) AND (creativity OR "creative engagement" OR "creative skills")

ScienceDirect variant: TITLE-ABSTR-KEY("artificial intelligence" OR AI) AND TITLE-ABSTR-KEY(education OR learning OR teaching OR pedagogy) AND TITLE-ABSTR-KEY(creativity OR "creative engagement" OR "creative skills")

IJAIED variant: ("artificial intelligence" OR AI) AND (education OR learning OR teaching OR pedagogy) AND (creativity OR "creative engagement" OR "creative skills") (applied to all searchable fields)

Appendix A.4. Language Restrictions

Only English-Language Publications Were Included

Appendix A.5. Time Frame: Publications Between January 2020 and August 2025: Last Search Conducted on 6 August 2025

Appendix A.6. Initial Yield and Screening

- ScienceDirect: 95 records retrieved.
- IJAIED: 59 records retrieved.

Total: 154 initial records. After removing duplicates, applying inclusion and exclusion criteria, and completing the screening process, 63 studies were included in the final review.

Appendix B. PRISMA Check List

Section/Topic	Item #	Checklist Item	Reported Location in Manuscript
Title	1	Identify the report as a systematic review.	Title page, line X
Abstract	2	See PRISMA 2020 for Abstracts checklist.	Abstract, lines X–Y
Introduction	3	Rationale: Describe the rationale for the review in the context of existing knowledge.	Introduction, Section 1
	4	Objectives: Provide an explicit statement of the objective(s) or question(s) the review addresses.	Introduction, end of Section 1
Methods	5	Eligibility criteria: Specify inclusion and exclusion criteria.	7
	6	Information sources: Specify all databases, registers, websites, organizations, reference lists, and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Methodology, Section 7; Appendix A
	7	Search strategy: Present the full search strategies for all databases, registers, and websites, including any filters and limits used.	Appendix A
	8	Selection process: Specify methods used to decide whether a study met the inclusion criteria, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used.	Methodology, Section 7
	9	Data collection process: Specify how data were collected from reports, how many reviewers collected data, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used.	Methodology, Section 7
	10	Data items: List and define all outcomes for which data were sought. List and define all other variables for which data were sought.	Methodology, Section 7; Table 1
	11	Study risk of bias assessment: Specify methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study, and whether they worked independently.	Methodology, Section 7 (not applied; stated as limitation)
	12	Effect measures: Specify for each outcome the effect measure(s) used in the synthesis or presentation of results.	Not applicable (narrative synthesis)
	13	Synthesis methods: Describe the processes used to decide which studies were eligible for each synthesis, any methods for tabulating or visually displaying results, and methods to explore heterogeneity.	Methodology, Section 7; PRISMA diagram (Figure 1)
	14	Reporting bias assessment: Describe any methods used to assess the risk of bias due to missing results.	Methodology, Section 7 (not applied; stated as limitation)

Table A0. *Cont.*

Section/Topic	Item #	Checklist Item	Reported Location in Manuscript
	15	Certainty assessment: Describe any methods used to assess certainty (or confidence) in the body of evidence.	Not applicable (narrative synthesis)
Results	16	Study selection: Report numbers of studies screened, assessed for eligibility, and included, with reasons for exclusions at each stage.	Results, Section 8.1; PRISMA diagram (Figure 1)
	17	Study characteristics: Cite each included study and present characteristics for which data were extracted.	Results, Section 8.2; Tables 1 and 2
	18	Risk of bias in studies: Present assessments of risk of bias for each included study.	Not applicable (not conducted; stated as limitation)
	19	Results of individual studies: For all outcomes, present for each study: (a) summary statistics, (b) effect estimates, (c) confidence intervals.	Not applicable (narrative synthesis only)
	20	Results of syntheses: Summarize the main findings of the review.	Results, Section 8.3; Discussion, Section 9
	21	Reporting biases: Present assessments of risk of bias due to missing results.	Discussion, Section 9 (limitation)
	22	Certainty of evidence: Present assessment of certainty (or confidence) in the body of evidence.	Not applicable (narrative synthesis)
Discussion	23	Discussion of results in the context of other evidence.	Discussion, Section 9
	24	Limitations of the evidence included in the review.	Discussion, Section 9
	25	Limitations of the review processes used.	Conclusions, Section 10
	26	Implications for practice, policy, and future research.	Conclusions, Section 10
Other Information	27	Registration and protocol: Provide registration information and protocol details.	Methodology, Section 7 (no protocol registered)
	28	Support: Describe sources of financial/non-financial support.	Funding statement
	29	Competing interests: Declare any competing interests.	Conflict of Interest statement
	30	Availability of data, code, and other materials.	Data Availability Statement

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