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Unleashing Creativity in Education, When Design Thinking Meet Technology: A Systematic Review

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ABSTRACT

This comprehensive analysis of the literature intends to investigate the relationship between design thinking and technology in fostering creativity in the field of education. The importance of encouraging creativity in students has grown significantly in educational research and practise as the world becomes more complicated and dynamic. With its emphasis on innovation and problem-solving and human-centred approach, design thinking has become recognised as a potential framework for fostering creativity in education. Concurrently, technological developments have created new opportunities and routes for incorporating design thinking ideas into educational contexts. This evaluation looks into how technology is now being used in educational settings to enhance design thinking in terms of research and practise. The study focuses on the use of design thinking principles and the function of technology in encouraging creativity among students by looking at a wide range of academic articles, that were published between 2013 and 2023. The review summarises the results from the chosen studies, spots trends, and highlights the most important ideas. The results of this review highlight the advantages of using technology and design thinking in education. Combining design thinking principles with the right technical tools and resources improves students' critical thinking, problem-solving skills, collaboration abilities, and general involvement in the learning process, according to a review of the research. The review also identifies numerous pedagogical approaches and methods that successfully combine technology and design thinking to foster creativity in a range of educational environments. The consequences of this study offer insightful information to researchers, policy makers and educators who want to improve creativity in school. Understanding how design thinking and technology work in concert allows stakeholders to create and implement educational interventions that foster creativity and provide students the skills they need to succeed in the twenty-first century.

Keywords:

Creativity; Design thinking; Technology; Education; Systematic review

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1. Introduction

In the field of education, there has recently been an increase in focus on the value of creativity in educating students for the challenging issues of the twenty-first century. Teachers and legislators are increasingly focusing on the need of fostering creative thinking and problem-solving skills in order to provide children the skills they need to flourish in a world that is changing swiftly [1]. The rapid advancement of technology integration in education has created new possibilities for improving the learning process. Design thinking's iterative process fosters a growth mentality by encouraging a willingness to try new things, learn from mistakes, and continuously improve concepts [2].

Design thinking is a well-known methodology for stimulating creativity and innovation across a variety of areas because it takes a human-centred approach to problem-solving [3]. Design thinking encourages students to examine alternative perspectives, challenge presumptions, and develop original solutions to problems that they encounter in the real world by focusing on empathy, teamwork, and iterative ideation.

Technology improvements have simultaneously permeated educational environments, giving teachers and students a variety of tools and resources to improve teaching and learning. Technology offers new ways to involve students, encourage active learning, and foster creativity, from interactive digital platforms and virtual reality simulations to coding and robotics [4].

Despite the abundance of options, it is vital to assess how well the application of design thinking and technology in education actually fosters creativity. There is a need to perform a thorough evaluation of the available research to get insights into the influence of this intersection on creativity in educational environments as the synergy between design thinking and technology appears as a potential approach [5,6].

In order to provide a thorough understanding of how design thinking and technology converge to unleash creativity in education, this systematic review attempts to analyse the present body of knowledge by synthesizing research findings, conceptual frameworks, and best practices. This review aims to identify the main enablers, obstacles, and consequences connected with this integration by critically analysing the current research, shining light on efficient methods for encouraging learners' creativity.

The review would adhere to a systematic process, ensuring accuracy in the selection and assessment of significant papers. Finding common themes, patterns, and gaps in the literature through a systematic review approach enables us to make recommendations for future research and practice that are supported by substantial data. In order to advance the body of knowledge and provide meaningful data for educators, decision-makers, and academics working to release students' creative potential in today's dynamic educational environment. By looking at how design thinking and technology intersect in education, it achieves this.

2. Literature Review

In the twenty-first century, creativity is acknowledged as a critical ability necessary for success across a variety of fields. Fostering creativity has emerged as a key objective in education as educators realize the value of giving pupils the tools they need to think critically, invent, and tackle challenging challenges [2]. Design thinking has drawn attention as a possible paradigm for fostering creativity in educational settings because of its human-centred perspective and emphasis on creativity and innovation [7,8] . Concurrently, technological developments have created new opportunities for applying design thinking concepts to educational practice. In order to examine

how design thinking and technology might be used to inspire creativity in education, this literature review will synthesize previous studies and highlight relevant findings.

Empathy, ideation, prototyping, and testing are key components of the iterative problem [9,10] solving process known as "design thinking" It inspires people to collaborate, think creatively, and come up with original answers to difficult problems. Design thinking provides a strong foundation for involving students in relevant and real-world learning experiences in the context of education [11,12] . Design thinking fosters critical thinking, cooperation, and creativity by concentrating on real-world issues and integrating students in the design process [9,10,13].

Technology has breathed new life into education, opening up exciting opportunities for creativity and innovation. Students now have a multitude of avenues through which they can unleash their creative potential, collaborate seamlessly with their peers, and tackle real-world problems with the help of digital tools, software, and online platforms [14-16]. The incorporation of multimedia elements, such as captivating audio, immersive video, and interactive media, further enriches their learning experiences and ignites their imagination [17,18] . With an array of digital tools, software applications, and online platforms at their fingertips, students are empowered to work together, communicate effectively, and express their creativity in diverse ways.

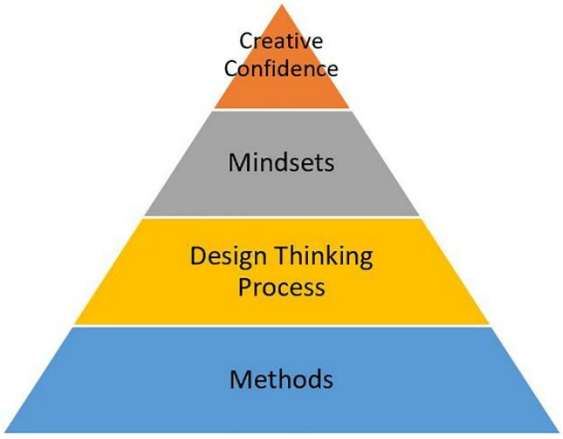

Fig. 1. Design thinking in instructional technology students [19]

This harmonious integration of design thinking and technology not only empowers students to solve tangible challenges and engage in immersive hands-on activities but also bridges geographical divides, connecting learners from different corners of the world and exposing them to a rich tapestry of perspectives [20,21] . Ultimately, this integration nurtures active creators, critical thinkers, and adept problem solvers, ready to make their mark in the digital realm.

Technology and design thinking in education have the power to boost imagination and develop 21st-century abilities [22,23] . The synergistic interaction between these two realms has been the subject of numerous investigations. Consider the term constructionism, which emphasizes how technology helps design thinking ideas and fosters creative learning [25] . They argued that technological advancements give students the tools they need to build their own knowledge and engage in real-world, project-based activities [19,26].

3. Material and Methods

3.1 Identification

In choosing several appropriate papers for this report, the systematic review process consists of three main phases. The first step is keyword recognition and the quest for linked, similar terms based on the thesaurus, dictionaries, encyclopaedia, and previous studies. Accordingly, after all the relevant keywords were decided, search strings on Scopus and ERIC (see Table 1) database have been created. In the first step of the systematic review process, the present research work successfully retrieved 209 papers from both databases.

The identification phase involves searching for study materials relevant to the predetermined research issue. The keywords used are design thinking and technology. Therefore, the first step was to detect keywords and search for similar, equivalent phrases in previous research. As a result, after determining all relevant phrases, search strings for the Scopus and ERIC databases were created (see Table 1). Thus, during the first part of the advanced searching procedure, this study effectively obtained 92 publications from the databases.

Table 1
Search strings for the Scopus and ERIC databases

Scopus	TITLE-ABS-KEY ("Design Thinking" AND "technology" AND creative AND education) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (LANGUAGE , "English"))
ERIC	"Design Thinking" AND "technology" AND creative AND education

3.2 Screening

Duplicated papers should be excluded during the first step of screening. The first phase omitted 117 articles, while the second phase screened 92 articles based on several inclusion-and- exclusion criteria developed by researchers. Literature (research articles) was the first criterion because it is the primary source of practical information. It also includes the exclusion from the current study of publications in the form of systematic review, review, meta-analysis, meta-synthesis, book series, books, chapters, and conference proceedings. Furthermore, the review concentrated exclusively on papers written in English. It is essential to note that the schedule was chosen for a ten-year duration (2013–2023). In all, 83 publications based on specific parameters were excluded.

3.3 Eligibility

For the third step, known as eligibility, a total of 83 articles have been prepared. All articles' titles and key content were thoroughly reviewed at this stage to ensure that the inclusion requirements were fulfilled and fit into the present study with the current research aims. Therefore, 48 reports were omitted because they were Full text excluded, due to the out of field (n=14), Title not significantly (n=16), Abstract not related on the objective of the study (n=18) based on empirical evidence. Finally, 35 articles are available for review (see Table 2)

Table 2
The selection criterion is searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Time line	2013 – 2023	< 2013
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press

3.4 Data Abstraction and Analysis

One of the assessment procedures employed in this study was integrative analysis, which was used to investigate and synthesise a variety of research designs (quantitative, qualitative, and mixed methods). The competence study's purpose was to discover significant themes and subtopics. The stage of data collection was the first step in the theme's development. Figure 2 depicts how the writers methodically examined a collection of 209 articles for assertions or material relevant to the current study's issues. The authors next reviewed the most recent significant papers on design thinking, technology and creativity education. The methods employed in all investigations, as well as the research findings, are being looked into. Following that, the author worked with other co-authors to build themes based on the data in design thinking and creative technology education (Mohd Ekram Hashim, expert in creative technology, Mohd Farizal Puadi, expert in creative art and Nursafinas Albakry, expert in design education) to determine the validity problems. The expert review phase ensures the clarity, importance and suitability of each subtheme by establishing the domain.

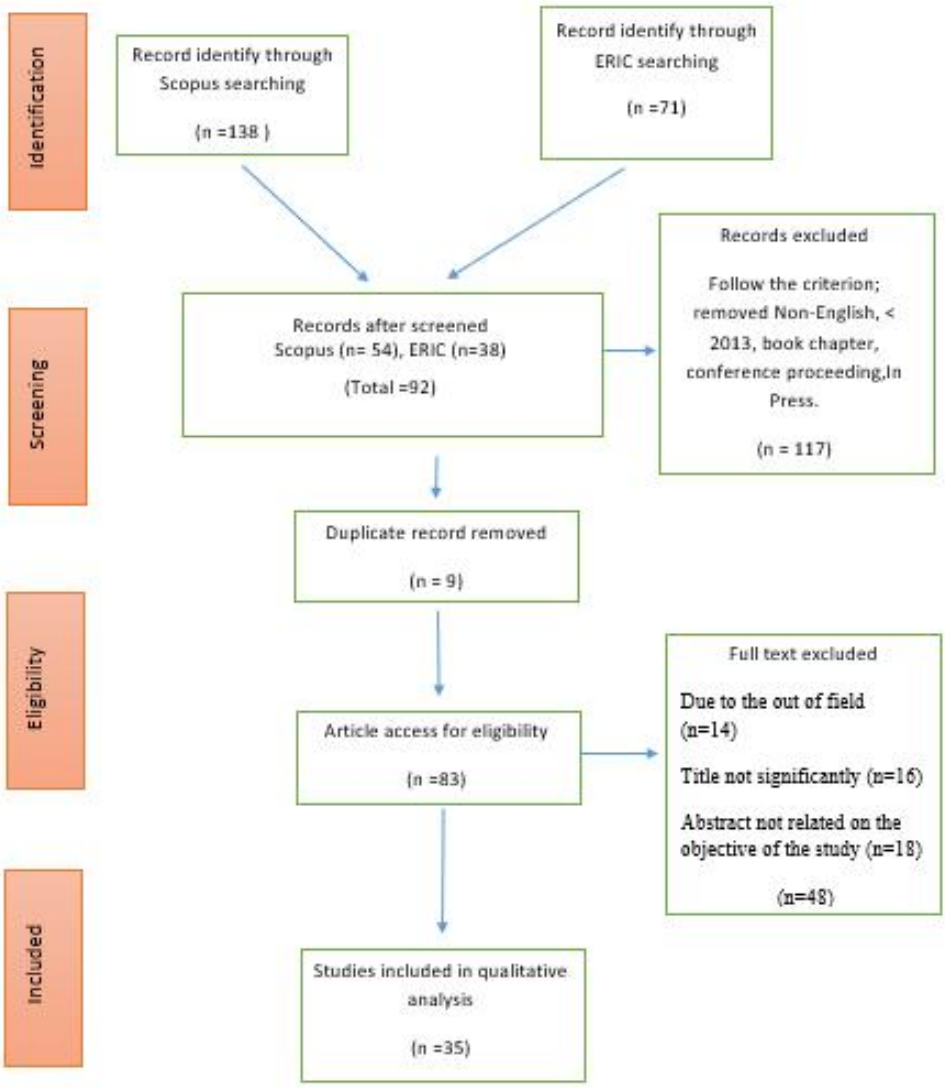

Fig. 2. Flow diagram of the proposed searching study [27]

4. Result and Finding Synthesis Analysis

4.1 Transformative Pedagogies: Fostering Creative Education through Design Thinking and Technology

The integration of design thinking and technology in education is a transformative approach that holds significant potential for fostering creative education. The rapid development of science, technology, and digital multimedia has brought about adjustments in all areas of design, impacting teaching methodologies and creating new demands [19,28] . As our society evolves, there is a growing need to produce applicants who can adapt to the development of modern society and meet the needs of the market. This necessitates a renewed focus on teaching methods that empower learners to cultivate creativity and foster innovation.

Consideration of new digital media technologies and their impact on teaching practices is one part of combining design thinking and technology in education. The evolution of these technologies has had a profound impact on the implications and forms of design, encouraging educators to experiment with new ways [29] . A new way of teaching can be established by leveraging digital media art design through the lens of design thinking approach. This method recognizes the

particular challenges of teaching in a digital media setting and attempts to provide learners with the skills and knowledge they need to navigate this changing terrain [39].

It is critical to overcome methodological problems and develop interdisciplinary collaboration in order to effectively use design thinking and technology in education. Incorporating design thinking ideas can help to bridge the gap between design and other disciplines, establishing shared learning environments that encourage cross-disciplinary collaboration [19,25,30] . Students can build actionable skills, expand their design vocabulary, and foster aesthetic appreciation by incorporating core design courses within an interdisciplinary programmed [5,6,16] . This multidisciplinary approach enables for the investigation of new possibilities and solutions that correspond with technological capabilities, enabling innovation in sectors as diverse as sciences, humanities, business, and technology [12,13].

The requirement for a new learning model that corresponds with the competences required for the future work scenario is a critical part of combining design thinking and technology in education. They have many learning models provides a promising framework that incorporates components from a variety of sources, theories, styles, authors, technology, and concepts. This approach is based on [22] triarchic theory of intelligence, which emphasizes the various types of intelligence necessary in different situations and tasks. One of them is The ECLECTIC 4.0 approach intends to prepare learners for future demands by embedding learning experiences in real-world corporate contexts, facilitating collaborative learning, connecting humanities to management, and promoting non-linear thinking [23,25].

Furthermore, research emphasizes the necessity of design thinking education in building knowledge about design processes and practices. Blogging as an educational technique has been demonstrated to assist design thinking education in online instructional technology courses [19,28]. It provides a forum for students to actively construct knowledge about design thinking and reflect on their personal design practices. However, difficulties develop for students who are less comfortable with narrative meaning-making and sharing ideas on open networks [31] . Addressing these problems and providing varied avenues for interaction are critical to ensuring the effective integration of design thinking and technology in educational contexts.

Another important part of integrating design thinking and technology in education is interdisciplinary collaboration [32,33]. Innovative design interventions can be generated by bringing together professionals from several domains, such as occupational therapists and designers. This collaboration allows for the development of assistive devices that address the unique needs of patients in rehabilitation settings. Students can improve their problem-solving talents and contribute to effective solutions in a variety of domains by introducing design interventions and interdisciplinary collaboration into the learning process [22,31].

Finally, incorporating design thinking and technology into education has enormous promise for creating creative education [33]. It necessitates careful study of modern digital media technologies, the creation of new learning models, the resolution of methodological issues, and the promotion of multidisciplinary collaboration. Educators may provide learners with the skills they need to flourish in a fast-changing society by embracing transformative pedagogies [30] . Design thinking and technology integration not only fosters creativity and innovation, but also trains students to be active players and problem solvers in the digital age and future work settings.

4.2 Exploring the Synergy: Unleashing Creativity through the Convergence of Design Thinking and Technology in Education

The fusion of design thinking and technology in the field of education offers a significant opportunity to promote innovation and provide students the power to spark revolutionary change in society [33]. This thorough synthesis analysis carefully examines the findings from a collection of academic studies with the overall goal of highlighting the transformative effects of the fusion of design thinking methodologies and technological advancements in educational settings.

The subject matter of what was studied was an investigation of relationships between college students from various geographical backgrounds in relation to changemaking and digital innovation. The researchers sought to examine the catalytic potential of leveraging immersive technologies, such as augmented and virtual reality, in advancing changemaking initiatives across international frontiers by employing a design thinking method of operation along with a thematic examination of student responses [36,37]. The results showed a discernible improvement in students' digital engagement and skill as well as a visible improvement in their cultural awareness and global mindfulness [20,21]. The collaborative, international digital projects created a favourable environment for developing changemaking skills, preparing the student body for beneficial contributions in the fields of entrepreneurship and education [11,16].

Design thinking emerged as a crucial creative process in the orchestration of projects, their management, and the production of products and services [6,34], underscoring the crucial relevance of sharpening problem-solving prowess. Through a series of varied design encounters over a brief period of time, this experiment hypothesized that even those without design backgrounds may engage in design thinking productively. The academic presentation included concrete examples that demonstrated how the design thinking paradigm could be used to reimagine and improve commonplace items. A captivating case study highlighted students taking part in a "Design Thinking" program, highlighting how engineering students without prior design expertise skilfully converted their innovative thoughts into useful results [4,5,9]. The application of design thinking methods aided the organic during the course of this inquiry, there was a convergence of many knowledge fields.

It is crucial to recognize the vital part that design pedagogy plays in developing critical design thinking skills and offering the necessary support for design practice. To address these imperatives, novel educational approaches, such as the creation of immersive learning environments, have been investigated [29,32]. One study examined the "Immerse Lab," a space distinguished by a three-wall projection room, for its suitability as a supportive environment for design practice, ideation, and the comparative evaluation of design artifacts [24,35]. The results of student polls lauded the merits of learning in the "Immerse Lab," with students recognizing clear benefits in comparisons to conventional tutorial locations. The immersive environment encouraged a diversity of viewpoints on design concepts, supported the emergence of original ideas, and acted as an inspirational crucible for the development of preexisting ideas [8,16]. It is also important to remember that the design of learning settings has a significant impact on how students learn and how satisfied they are in general. An alternative paradigm for the creation of learning environments was put forth in a study report, one that included input from students and educators—two crucial stakeholders [11,35]. Participants engaged in a qualitative inquiry within "sandpits," which served as workshops based on design-thinking ideas, to examine and improve technology-enhanced learning environments. Participants in these workshops discussed the function of technology in face-to-face education, disputed its seamless integration, and proposed creative design solutions. Students and

teachers working together during the planning phase ensures that learning environments best utilize technology to fulfil the diverse needs of all stakeholders.

In summary, the integration of design thinking and technology into educational paradigms acts as a powerful catalyst for fostering creativity, empowering students, and giving them the agency to bring about transformative change. The synthesis of numerous research projects reveals the paradigm-changing impact of using design thinking approaches and technology in the context of education. Through the thoughtful integration of immersive technologies, the embracement of interdisciplinary collaborations, the cultivation of inspiring learning environments, and the active inclusion of stakeholders in the design ethos, educators stand poised to unleash the full spectrum of creative potential within education. This combination enables students to think critically, traverse challenging issue environments, and contribute meaningfully to society, paving the way for a better and more prosperous future for all.

4.3 Empowering Learners: Design Thinking, Technology and Creative Education in the Digital Era

There has been a noticeable increase in interest in the empowerment of learners through the fusion of design thinking, technology, and creative education in the modern environment of rapid digital advancement. The purpose of this academic synthesis analysis is to shed light on the significant and transformative effects brought about by the introduction of design thinking methodologies and technology into educational contexts. It does this by meticulously examining the findings drawn from a wide range of research papers. The main goal is to inspire students' creativity and give them the tools they need to deal with the complex problems of the twenty-first century.

The initial research inquiry sets out to critically examine the complex relationship between technology education and creative thinking, posing compelling questions about the current structure of technology curricula and its potential barriers to the promotion of efficient design thinking [1]. The fundamental value of creativity, imagination, and human sensibilities within the design process is prominently emphasized in the article. It advances the idea that in order to free the ability for creative problem-solving, a break from rigorously defined aims and mandatory components is necessary.

The influence of STEAM (Science, Technology, Engineering, Arts, and Mathematics) education programs based on the principles of Design Thinking on elementary school students is then explored through an empirical study [1,34]. The effectiveness of using educational content as a means of fostering creative aptitude in scientific and technological domains, all the while boosting communication and collaboration proficiencies, is carefully examined in this study. The empirical results confirm the effectiveness of STEAM education based on Design Thinking principles in fostering the development of creative talent, a heightened interest in science and engineering, and a greater propensity among students to consider careers in these fields. Notably, these results have greater significance when examined in the context of earlier research that demonstrated that female students' excitement for science and technology gradually declines as they go through their academic careers [38].

The many advantages of combining STEAM disciplines are explained by a thorough conceptual framework that is developed in another academic study and supported by the use of design thinking and computational thinking approaches [2,11]. The framework emphasizes the value of combining components from many laboratories, including the maker's laboratory and physical computing, in a deliberate attempt to improve daily STEM instruction. It repeatedly emphasizes how important design thinking is as a guiding educational principle, giving teachers the freedom to

adopt transdisciplinary, imaginative, and project-based instructional paradigms. This academic article also offers teachers practical, step-by-step advice for incorporating design thinking ideas into their pedagogical practices in a seamless way. This facilitates the development of experiential, hands-on learning opportunities and the comprehensive integration of STEAM learning components.

Additionally, the current research project explores the application of Design Thinking as a user-centred, cross-disciplinary technique that is effective in fostering innovative thinking and problem-solving skills [9,12]. The authors give examples of how Design Thinking courses have been successfully taught in academic settings as examples of this strategy, with a focus on giving students with technical backgrounds and analytical mindsets the skills necessary for creating media innovations. The study provides a thorough explanation of the Design Thinking curriculum, the course's organizational structure, its overarching goals, its practical methods, and its theoretical foundations. The article acts as a model for how such courses might be set up in a university setting with the express purpose of fostering critical thinking and problem-solving skills beyond the current norm. [13,20].

In conclusion, the synthesis analysis, which was developed from a collection of several research papers, unmistakably emphasizes the necessity of empowering students in the digital environment through the fusion of design thinking, technology, and creative education. Educators may encourage creativity, develop students' problem-solving skills, and promote cross-disciplinary collaboration by carefully integrating design thinking methodologies and leveraging technology's revolutionary potential. This educational strategy is distinguished by its ability to increase student engagement, rekindle interest in STEM fields, widen career options, and give students the essential skills needed to succeed in a world that is becoming more complex and linked. In this way, educators build the foundation for a transformative educational journey that both empowers students and equips them to face the opportunities and challenges that the future offers by adopting design thinking and smoothly integrating it into their curricula.

5. Conclusion and Discussion

This systematic review investigates the topic of "Unleashing creativity in education, when design thinking meets technology." The results demonstrate how design thinking and technology, especially in the digital age, may support creative teaching. Educators may develop dynamic learning environments that empower students and foster their creative potential by incorporating design thinking ideas and technological technologies.

The intersection of design thinking and technology offers a once-in-a-lifetime chance to boost creativity in educational settings. When linked with technology, design thinking, with its emphasis on problem-solving, collaboration, and invention, extends the possibilities for creative expression and involvement. It gives students the skills and mindset they need to solve complicated situations, investigate many perspectives, and generate new solutions.

Transformative pedagogies are critical in promoting creative education. Educators can enhance active learning, critical thinking, and problem-solving skills in students by incorporating design thinking and technology. The incorporation of technology, such as interactive digital platforms, virtual reality, and multimedia materials, not only broadens avenues for creativity, but also improves educational accessibility and inclusivity.

However, successful integration of design thinking and technology in education necessitates careful planning. To effectively incorporate design thinking principles into their teaching approaches, educators require suitable training and support. It is critical to match technology

integration with pedagogical aims, ensuring that it enhances creativity and learning outcomes rather than being exploited for its own sake.

More study is needed to investigate the specific influence of design thinking methodologies and technological tools on creativity, learning outcomes, and student engagement in the future. Educators' roles in promoting creative education through design thinking and technology should also be investigated, and best practices for implementation should be found.

Ultimately, the intersection of design thinking and technology in education has the potential to unleash creativity and empower learners. By embracing this combination, educators may develop transformative learning environments that equip students with the necessary abilities for the constantly changing digital world. We can further leverage the power of design thinking and technology to encourage creative education and prepare students for the challenges and possibilities of the future through continuous research and exploration.

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