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AI and STEAM Integration in Distance Education: Boosting Engagement and Skill Development in Greek Primary and Early Childhood Education.

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Ενσωμάτωση της Τεχνητής Νοημοσύνης και του STEAM στην Εξ Αποστάσεως Εκπαίδευση: Προάγοντας την Συμμετοχή και Ανάπτυξη Δεξιοτήτων στην Ελληνική Πρωτοβάθμια και Προσχολική Εκπαίδευση.

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Abstract:

This literature review begins through tracing the common ground between Artificial Intelligence (AI) technology and distance education. However, it most importantly investigates the integration of Artificial Intelligence (AI) technology within the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach in primary and early childhood educational settings, particularly focusing on the Greek context and whether the synergy among AI technology, STEAM and distance education exists. Drawing on existing literature, the review found a consistent positive impact of educational AI tools (EAIT) on students' educational engagement and the development of crucial 21st-century skills. AI's capacity for personalized learning and differentiated instruction is highlighted as a significant benefit, promoting inclusive learning by adapting to individual student needs. The paper discusses how various AI tools, can enhance classroom enjoyment and foster students' curiosity and imagination. It also examines the Greek Ministry of Education's proactive stance on integrating STEAM and what actions are being taken. While acknowledging the vast potential, the review also addresses challenges and the critical need for instructors' familiarization with educational AI tools. This synergy of AI, STEAM, and distance education is presented as a transformative force in preparing learners for a technologically driven, interconnected world.

Keywords

artificial intelligence, STEAM, distance education, primary education, early childhood education (ECE), Greece.

Περίληψη

Αυτή η βιβλιογραφική ανασκόπηση ξεκινά εντοπίζοντας τα κοινά σημεία μεταξύ της Τεχνητής Νοημοσύνης (ΤΝ) και της εξ αποστάσεως εκπαίδευσης. Ωστόσο, το σημαντικότερο είναι ότι διερευνά την ενσωμάτωση της Τεχνητής Νοημοσύνης στην προσέγγιση STEAM (Επιστήμη, Τεχνολογία, Μηχανική, Τέχνες και Μαθηματικά) σε εκπαιδευτικά περιβάλλοντα πρωτοβάθμιας και προσχολικής εκπαίδευσης, εστιάζοντας ιδιαίτερα στο ελληνικό πλαίσιο και στο κατά πόσο υφίσταται η συνύπαρξη μεταξύ της ΤΝ, του STEAM και της εξ αποστάσεως εκπαίδευσης. Βασιζόμενη στην υπάρχουσα βιβλιογραφία, η ανασκόπηση διαπίστωσε συνεπή θετική επίδραση των εκπαιδευτικών εργαλείων τεχνητής νοημοσύνης στην συμμετοχή των μαθητών στην εκπαιδευτική διαδικασία και στην ανάπτυξη δεξιοτήτων του 21ου αιώνα. Η ικανότητα της ΤΝ για εξατομικευμένη μάθηση και διαφοροποιημένη διδασκαλία αναδεικνύεται ως ένα σημαντικό όφελος, προωθώντας την συμπεριληπτική μάθηση μέσω της προσαρμογής στις ατομικές ανάγκες των μαθητών. Η εργασία συζητά πώς διάφορα εργαλεία AI μπορούν να ενισχύσουν την ανάπτυξη θετικών συναισθημάτων των μαθητών στην τάξη και να ενθαρρύνουν την περιέργεια και τη φαντασία τους. Εξετάζεται επίσης η δυναμική στάση του Ελληνικού Υπουργείου Παιδείας όσον αφορά την ενσωμάτωση του STEAM και οι ενέργειες που εφαρμόζονται. Αναγνωρίζοντας τις απεριόριστες δυνατότητες, η ανασκόπηση προβάλλει επίσης τις προκλήσεις και την ζωτικής σημασίας ανάγκη εξοικείωσης των εκπαιδευτικών με τα εκπαιδευτικά εργαλεία ΤΝ. Αυτή η σύμπραξη της ΤΝ, του STEAM και της εξ αποστάσεως εκπαίδευσης παρουσιάζεται ως μια μετασχηματιστική δύναμη στην προετοιμασία των μαθητών για έναν τεχνολογικά καθοδηγούμενο, διασυνδεδεμένο κόσμο.

Λέξεις- Κλειδιά

τεχνητή νοημοσύνη (ΤΝ), προσέγγιση STEAM, εξ αποστάσεως εκπαίδευση, Πρωτοβάθμια Εκπαίδευση, προσχολική εκπαίδευση, Ελλάδα.

Introduction

Artificial Intelligence (AI) integrated through STEAM approach in distance education settings can be considered as a groundbreaking method in order to ensure success in student engagement and provision of adaptive and flexible learning, surpassing time and spatial limitations. Moreover, the interrelation of the three can lead to distancing from conventional teaching practices and traditionally siloed subjects, establishing cross-disciplinary and real-world relevant educational ecosystems. Finally, inclusivity alongside with educational equity are fostered; at this point it is essential to mention that the co-existence of STEAM and AI within distance education environment promotes one of the fundamental principles of open education which is the openness and accessibility by everyone (Lionarakis, 2006). Distance education constitutes a field characterized by polymorphism and there have been multiple attempts to define its scope and essence (Lionarakis, 2006). It is almost certain that in the era of AI distance education will be unavoidably transformed and that new educational theories and methods will emerge.

This paper constitutes a literature review aiming to investigate the literature which addresses the Artificial Intelligence (AI) technology through implementation of the STEAM approach through AI tools and platforms in Primary and Early Childhood Education (ECE) in Greek educational settings. On a second level, there is an attempt to trace common ground among the fields of AI technology and distance education alongside with its values and its needs. The research questions that the current paper attempts to answer is:

- How does the application of the STEAM approach through the utilization of educational AI tools (EAIT) within distance education settings impact student engagement and 21st – century skills in Greek primary and early childhood education?
- What are the challenges concerning the integration of AI educational tools in STEAM-based teaching practices in Greece? What actions are being taken by the Greek government to ensure the Greek educational systems' readiness?

The paper commences by tracing the common ground between distance education and AI technology. Subsequently, it examines the vital role of STEAM approach as an interdisciplinary field, highlighting its role in endowing students with 21st-century

skills. Furthermore, within the part of literature review, the synergy of AI educational tools, STEAM and distance learning is being discussed as a means of reshaping the Greek educational landscape preparing the students for a digitally oriented, interdependent world. The study also focuses on the Greek educational system and presents what actions and policies are being underway in order to bring Greece closer to digital revitalization. The methodology part analyzes the kind of research method that was followed for the specific study presenting the reasons that lie behind its selection. Last but not least, in the part of the results, the research questions are answered based on the collected data. Concluding, in the final segment of the paper potential effective teaching steps are recommended and general comments and thoughts are expressed.

Literature Review

Distance Education under the prism of AI technology

Artificial Intelligence (AI) is a field of science and technology whose task is to create computer systems and devices capable of performing tasks that require human intelligence (Ghosh, Chakraborty, Law, 2018, p. 208). Digital education can be defined as a learning technique which is based on the use of digital infrastructure and media of communication, such as the internet, virtual classrooms, learning management systems and multimedia platforms (Bates,2011). The utilization of technological tools as the internet and the intranet facilitated the interactive element of this kind of learning. Distance education itself represents a groundbreaking field as it has revolutionized how humans access knowledge and learn (Riad, El-Minir, El-Ghareeb, 2009).

When supported by artificial intelligence, distance education becomes a hybrid that represents a crucial revolution in access to knowledge, the adaptation of teaching materials, and the personalization of the teaching process (Christ, 2013). The applications of artificial intelligence in the distance education process are multifaceted, encompassing the ability to create customized teaching materials, advanced interactive working environments, and almost complete automation of the verification process of students' educational accomplishments (UNESCO, 2019, p. 12). These advancements facilitate a more tailored learning experience, catering to

individual needs and preferences. Advanced AI algorithms, continually refined, become increasingly effective and universal, regardless of the educational level, subject area, or particularities of students. Supporting the education process in a remote environment through broadly defined artificial intelligence not only serves as a didactic tool but, above all, transforms our understanding of the education process (Chen L., Chen P., Lin Z., 2020, p. 8). This transformation highlights the shift from a one-size-fits-all approach to a more student-centered model that values individual learning journeys. This synergy opens new horizons for access to knowledge, adapting the teaching process to individual student needs, and creating interactive and effective educational environments (Omirzak, Alzhanov, Kartashova, Ananishev, 2022, p. 568)

Through the use of AI, learners are exposed to a personalized model where algorithms analyze the time spent on tasks and the number of attempts made for each. In the remote education environment, AI systems adjust the difficulty level of tasks in real-time (Sayed, Noeman, Abdellafit, 2023, p. 3303-3333). If a student copes easily, the pace is adjusted by skipping tasks of a similar difficulty level. This dynamic adaptation helps to prevent dullness and frustration, promoting a livelier learning experience. In case of challenges, algorithms adjust the pace, provide hints, or skip specific tasks. This approach allows for the maximum optimization of the education process, under the teaching methodologies of connectivism and social constructivism within the principles of individualization and teamwork, which would be difficult to achieve in a traditional classroom setting. Individualizing the education process has a very positive impact on developing students' individual talents and passions, preparing them for future challenges (Li X, Li Y, 2023, p. 1-20). Through the development of skills such as creativity, independent thinking, and interpersonal skills, students are likely to develop the desired skills for the 21st century citizens (Warchoł, 2023).

STEAM as an Interdisciplinary Field

Based on the above, there is a clear correlation among the fields of distance education, AI tools and STEAM (Science, Technology, Engineering, Art and Mathematics) approach. STEAM is a novel teaching trend which is bound to dominate the classrooms of all around the world. Thanks to its numerous advantages not only in meliorating

teaching practices but also in forming 21st century citizens and providing them with the life skills, learners are going to be endowed with the assets needed for the years to come. Nowadays, STEAM education has expanded its field of implementation and there is a plethora of training programs that address to kindergarten teachers or teachers of other specialties such as language teachers in order to incorporate this fascinating approach into their teaching style.

Research has found that art can help early childhood teachers to encourage creativity in young children (Yakman, 2008) and provide a space to personalized the meaning making process which will impact on children's motivation to continue to engage with STEAM (Land, 2013; Wynn & Harris, 2012). Sullivan et al. (2013) suggested that STEAM practices derived from STEM, with an additional subject arts being included can complement early childhood STEM education, wherein the "A" in STEAM covers the area of visual art and crafts, liberal arts, linguistic arts, social studies, music, and culture. Thus, it is crucial to establish a universally accepted, evidence-based and recognized understanding of integration as it impacts the introduction of STEAM in curriculum and practices which will be reflected on children's growth and development. A seminal framework established by Vasquez et al. (2013) attempted to distinguish between the different levels of STEAM integration. This framework removes the traditional barriers of segregating the four STEAM disciplines while applying real-world, authentic learning experiences for children. Vasquez et al. (2013) articulate STEAM education as an approach to teach discipline-based subjects beyond the surface level, which means teachers are curating conditions for children to learn to develop the so-called 21st century skills, significant for children to navigate in a new and fast developing world (Bybee, 2013). Examples of 21st century skills include the ability to construct knowledge, communicate, collaborate to solve real-life problems, and safe and appropriate use of information and communications technologies (ICT) (Partnership for 21st Century Learning, 2016; Stehle & Peters-Burton, 2019). These skills are being developed in the very young child, thus making a natural link between 21st century skills, STEAM education, and the young child's learning. In another study that conceptualizes integrated STEAM education, Kelley and Knowles (2016) define integrated STEAM education as "teaching the STEAM content of two or more STEAM

domains, bound by STEAM practices within an authentic context to connect these subjects to enhance student learning" (p. 3).

The primary purpose of STEAM education is to enable children to establish relationships between concepts and to develop critical thinking, collaboration, problem-solving, and creativity skills for children to understand STEAM areas (DeJarnette, 2018). Studies focus on how STEAM education supports children's creative problem solving skills, improving their knowledge, skills, and meanings and solving 21st-century problems (Liao, 2016). STEAM applications also develop curiosity, creativity, or collaboration skills that directly affect learning (Chesloff, 2013). STEAM education contributes to children's academic success at the next level (Morgan et al., 2013). In addition, a study determined that children's communication, cooperation, and creativity skills improved through dance-integrated robotic applications (Sullivan & Bers, 2018). These results are essential for the effectiveness of STEAM education.

STEAM, AI and Distance Education synergy in Primary and Early Childhood Education Settings

Primary education constitutes the first stage of formal schooling, typically following preschool or kindergarten and preceding secondary education. It targets to students' provision with core skills in reading, writing, and mathematics (literacy and numeracy), and establishing a solid foundation for learning and understanding core areas of knowledge and personal development. The age range for primary education can vary but commonly includes children from around 5-8 years old to 11-12 years old, with a typical duration of six years (UNESCO, n.d.).

Early Childhood Education (ECE) encompasses the formal and informal care and education of children from birth up to approximately eight years of age. This critical period of development focuses on nurturing a child's holistic growth across cognitive, social-emotional, physical, and language domains. ECE programs aim to build foundational skills, attitudes, and learning patterns that prepare children for formal schooling and lifelong learning. It often involves play-based and experiential learning approaches (American Public University, 2024)

Distance education, AI education tools, and the STEAM (Science, Technology, Engineering, Arts, Mathematics) approach are closely correlated, each reinforcing and

enhancing the benefits of the others in modern learning environments. Artificial Intelligence (AI) is being embedded within open and distance e-learning models to deliver personalized, adaptive, and interactive content for STEAM subjects. AI-driven platforms in distance education allow real-time feedback, adaptive assessments, and immersive simulations—making learning more personalized, flexible, and effective for a geographically diverse student population (Shabalala,2024).

Secondly, AI tools process large amounts of student data to adapt teaching methods and materials to individual learning needs, which is essential in STEAM fields that often require hands-on, inquiry-based learning. This personalized approach helps address varying levels of prior knowledge, learning styles, and pacing in distance education while ensuring accessibility and inclusivity for all learners (Glushkova & Malinova,2024). Moreover, interdisciplinary STEAM Learning is enabled as in both classroom and online settings, AI supports cross-disciplinary STEAM activities by enabling activities such as virtual labs, AI-powered scientific experiments, collaborative artistic and engineering projects, and data analysis tools that span across science, math, and arts. Such applications foster creativity, critical thinking, and real-world problem-solving skills (Brahimi & Sariete, 2024).

Last but not least, institutions globally use AI-driven distance education programs for STEAM subjects, blending adaptive curricula, AI-powered tutoring, and collaborative digital projects. These initiatives showcase how combining AI tools with the STEAM approach in an online context can deliver immediate feedback, global collaboration, and personalized learning pathways that would be difficult to replicate in traditional classrooms (Glushkova & Malinova,2024).

In conclusion, Distance education platforms empowered by AI tools make STEAM-based learning more accessible, personalized, and engaging—providing students with hands-on, creative, and interdisciplinary experiences regardless of their location. This correlation is transforming education by preparing learners with the skills needed for a tech-driven, interconnected world. Based on the above, the implementation of AI in primary and Early Childhood Education (ECE) is an up-and-coming field; numerous AI tools such as Suno, Code Monkey, Scratch and Canva to name just a few, can serve as exquisite “assistants” in order to make classes even more enjoyable and futuristic capturing students’ curiosity and imagination. Henceforth, the synergy of AI

technology and distance education can promote active student engagement and enable increased interest in learning through the STEAM method and building a positive attitude towards fields that can be considered as arduous by students, for example science or mathematics. Finally, the inclusion of the arts fosters empathy (Leavy et al., 2023), cultivating an open-minded mindset and creative-thinking alongside with children's linguistic and artistic development.

The Greek Educational Settings

The Greek Ministry of Education has increasingly recognized and integrated the STEAM approach into its educational policies and practices, fostering a more holistic and interdisciplinary learning environment. While traditionally the focus might have been on STEM (Science, Technology, Engineering, Mathematics), there's a clear trend and explicit efforts to include "Arts" (STEAM) to foster creativity, innovation, and critical thinking. To analyze further, the integration of "Skills Labs" constitutes a key initiative in compulsory education (primary and secondary schools). These labs aim to strengthen students' soft skills, life skills, and crucially, digital and science skills. This framework provides a natural avenue for the implementation of STEAM activities, including educational robotics and project-based learning.

Additionally, the Ministry of Education, Religious Affairs and Sports has explicitly focused on procuring robotics and STEM equipment for schools across all levels (kindergarten, primary, and secondary). This significant investment (e.g., 30 million euros for over 177,000 robotics sets) aims to familiarize students with programming, technology, problem-solving, teamwork, and analytical/synthetic thinking (Hellenic Republic, law 5128/2024). It also reinforces the upgrade of curricula to incorporate digital skills and the development of rich digital educational materials. Last but not least, there's a clear commitment to providing targeted professional development and training for teachers in innovative teaching methods, including those related to STEAM and inclusive education practices.

The inclusion of "Arts" in STEAM is seen as a way to enhance creativity, imagination, and to provide more options for teachers to present STEM concepts in engaging ways, particularly at the elementary and early childhood levels. The aim is to activate both analytical and creative sides of students' brains. Greece actively participates in

European initiatives and projects (like Erasmus+ funded projects such as "L-STEAM" and "SpicE") that promote STEAM education. These projects often focus on developing competence-based frameworks, supporting educators' professional development, and implementing student-centered STEAM activities in schools. The overarching goal of the Ministry's approach to STEAM is to equip students with the necessary 21st-century competencies, such as critical thinking, problem-solving, collaboration, and creativity, to address global challenges and prepare them for future education and the workforce. Finally, the Ministry encourages the collection and sharing of STEM and STEAM school projects and supports collaborations between educational institutions and universities to foster innovation in education (UNESCO, n.d.).

Notwithstanding, as far as the acceptance of Educational AI Tools (EAIT) in Greek educational settings is concerned, a study conducted by Velli and Zafiropoulos (2024) has highlighted the need for targeted professional development that addresses the specific concerns and needs of teachers, ensuring they are adequately supported in their transition to using AI tools in their classrooms. There is also suggested the importance in development of effective strategies for the implementation of educational AI, with the aim of improving teachers' instructional performance and consequently students' learning experiences. According to the specific research, fostering a culture of innovation and trust and providing adequate resources and support, such as the development of professional programs, which promote student-oriented pedagogical approaches and align with the potential of EAIT.

Finally, a Blueprint for Greece's AI Transportation was created in 2024 that has proposed certain guidelines for K-12 education; these guidelines include national curriculums transformation towards an AI tiered approach, AI integration in traditional subjects such as math, science and language. What is more, AI-related educational materials delivery through a central platform supporting teaching and learning, virtual collaboration, and hosting AI competitions is another crucial guideline that has been proposed. Last but not least, educators' training to leverage AI in the classroom seems to be of pivotal importance, as they are going to utilize multimodal generative AI tools in educational settings. It cannot be stressed enough that equipping teachers with the knowledge and the skills to bring AI tools into the

classroom and to teach AI concepts, a more cohesive and effective educational framework will be created (A Blueprint for Greece's AI Transformation, 2024).

Methodology

To ensure a valid and transparent approach, the survey of the literature on AI in conjunction with distance learning through STEAM approach used the systematic literature review paradigm. Due to the fact that the topic that this study proposes is novel and still under investigation with new evidence being discovered every year, the author has chosen to follow literature review as a methodology design since as a research method is more relevant than ever (Snyder,2019). A literature review can broadly be described as a more or less systematic way of collecting and synthesizing previous research (Baumeister & Leary, 1997; Tranfield, et al., 2003). An effective and well conducted review as a research method creates a firm foundation for advancing knowledge and facilitating theory development (Webster & Watson, 2002). By integrating findings and perspectives from many empirical findings, a literature review can address research questions with a power that no single study has.

Regarding the research strategy, the following steps were followed:

- Databases Searched: Major academic databases i.e., Scopus, Web of Science, ERIC, and Google Scholar.
- Keywords Used: "AI Educational Tools ", "STEAM education", "primary education", "Early Childhood Education", "Greek educational system".
- Search Period: Studies published between 2018 and 2025 to ensure recent and relevant findings.
- Language: English-language publications, with some inclusion of Greek-language articles if highly relevant to the national context.

There was an analysis of academic papers, legal documents and policy proposal that were selected based on specific inclusion criteria that entailed peer-reviewed empirical studies, systematic reviews and meta-analyses. What is more, research focusing on synergy of AI, distance learning and STEAM approach in education, particularly within Greek primary and early childhood ecosystems. Firstly, there was a selection of studies that combined AI and distance education in order to enlighten the

connection between the two. On a second level, it was considered of pivotal importance studies addressing STEAM educational practices in conjunction with AI educational tools to be included as they would shed light to disclose the benefits of the use of AI technology under the prism of STEAM approach in elementary and ECE educational settings. Finally, in light of necessity for melioration of the Greek educational system regarding the use of AI educational tools through STEAM-based teaching practices in order to provide premium quality and personalized education in primary and ECE teaching, research that is relevant to the Greek educational context was included.

Thus, the data were analyzed and organized thematically around the synergy of AI educational tools, STEAM approach and distance learning in Greek educational settings.

Below there is a checklist of the inclusion criteria:

- Publication Type: Peer-reviewed empirical studies, systematic reviews, and meta-analyses.
- Thematic Focus: Research specifically concentrating on AI technology in conjunction with distance education, STEAM approach within AI educational tools, particularly within primary and early childhood education.
- Interdisciplinary Relevance: Studies addressing STEAM educational practices in conjunction with distance education, to highlight the benefits of integrating AI technology within the STEAM approach.
- Contextual Relevance: Research pertinent to the Greek educational context, given the focus on improving the Greek educational system regarding AI educational tools usage through STEAM-based teaching practices.
- Publication Period: Studies published between 2018 and 2024 to ensure the inclusion of recent and relevant findings.
- Language: Primarily English-language publications, with strategic inclusion of Greek-language articles if highly relevant to the national context.

The exclusion criteria related to

- Little Relevance: articles that were not as relevant to the topic as desired.

- Frequency: articles that were met in more than one search engines were not selected either.

Results

As far as the first research question is concerned, based on the existing literature review it was found that there was a positive impact on students' educational engagement and 21st-century skills' development through the integration of AI educational tools in STEAM teaching practices in primary or early childhood education ecosystems. Secondly, AI's synergy with distance education can be of benefit as well since students will be able to practice skills at home.

AI integration can lead to personalized learning and differentiated instruction; notions which are of utmost importance in today's classroom since the striking majority of students may experience special accommodation needs. Moreover, AI through STEAM approach can contribute decisively in the achievement of inclusive learning. Through applications such as Openart.ai, Khan Academy, Code Monkey, Scratch, Tynker or Google Teachable Machine teachers can guide their students while they immerse themselves into creating their own micro worlds and computational environments in order to comprehend better concepts in science, technology or engineering whilst they develop their critical thinking, problem-solving and cooperation skills.

Furthermore, AI tools can support the "A", Art, in STEAM approach since they can facilitate digital art, design and music. Henceforth, creativity and problem-solving skills are fostered in an innovative way which applies to the 21st century skills that educators endeavor to cultivate to their students' mindsets. An instance of such a tool is Openart.ai through which students can generate images and videos from scratch through the use of simple ideas either based on existing images or texts. The specific tool can be extremely helpful for primary and kindergarten teachers as young learners have an excessively vivid imagination and would be a great opportunity to create their own story through assistance of AI technology.

Regarding the second, double research question, it is necessary to point out that although the field of AI educational tools that promote STEAM approach in ECE, primary up secondary educational settings is vast and wondrous, there are certain challenges and limitations that need to be considered. Drawing on the existing

literature there are ethical issues on AI implementation that involve students' data protection or prevention of bias on AI-generated content. As far as Greek educational system is concerned, there are certain actions that have been underway regarding specific principles and educational policies in order to ensure a normal transition to AI educational era. Additionally, it is crucial that schools adopt an AI policy in order to ensure the proper utilization of the AI-powered educational tools and platforms (A Blueprint for Greece's AI Transformation, 2024). Ultimately, teachers' training and readiness for the AI dominated world is of utmost importance as they are the people who are going to prepare future generations for the world of AI. It is significant that students be prepared in an ethical and proper way in order to use AI technology in a wise and effective way.

Discussion and Educational Suggestions

STEAM approach is an interdisciplinary teaching method which is applied on a global scale by numerous instructors. Its advantages are harvested by students of all levels and ages since there is a plethora of materials and scenarios that can be adjusted and applied in any age. To become more specific, in Early Childhood Education STEAM approach can only benefit students owing to its trans disciplinary character and can also assist children into developing computational thinking, problem-solving skills and learn how to act as researchers thanks to project-based and inquiry based learning.

Contemporary learning methodologies such as social constructivism and connectivism can be applied through STEAM approach which can be combined with AI technology. Based on the key principle of connectivism that everyone is connected all the time, we can take the most of AI technology through its careful and pedagogically-oriented implementation whilst staying connected and sharing ideas and knowledge with other colleagues through suitable platforms and softwares.

Educators can follow some basic and simple steps so that they could implement AI tools in their STEAM teaching practices; these can include:

- Define clear learning objectives and align AI tools with STEAM learning goals: Educators should start by specifying learning objectives and ensuring that any AI tool aligns with pedagogical goals based on the STEAM approach, rather than being used for the sake of novelty. Identifying educational needs first

ensures AI adds real value to teaching, learning and that serves the principles of STEAM.

- Research, evaluate and select the appropriate AI Tool: Before classroom utilization, teachers should research available AI options, review privacy and ethical guidelines, and, if possible, test tools to confirm their suitability and relevance to the STEAM approach. Consider usability, adaptability, and the age-appropriateness of features.
- Plan integration strategies: Teachers should determine exactly how AI will fit into lesson plans—whether it's for formative assessment, project-based learning, or administrative tasks—and provide scaffolding so all students benefit from its use. This includes planning support for both teachers and students unfamiliar with the technology.
- Prepare and train students: Introduce the AI tool to students by clearly explaining its purpose, which parts of the STEAM approach are going to be explored (if specific parts of it are taught), ethical considerations (like bias or data privacy), and limitations. Provide guided, hands-on practice so students can use the technology effectively and responsibly.
- Supervise and guide usage: Active supervision is crucial to ensure responsible tool use and to provide help when technical or conceptual challenges arise. Teachers should foster critical thinking skills by encouraging students to fact-check AI-generated information.
- Access impact and gather feedback: Regularly evaluate the impacts of the AI tool on learning outcomes using assessments and direct feedback from students. STEAM journals and worksheets could seem useful at this stage. Upon feedback collection adjust lesson plans and refine tool use based on real-world classroom experience.
- Reflect, update and stay informed: Continuous professional development and awareness on AI and STEAM synergy are key. Integrating feedback from the classroom is crucial, as well. Stay informed about policy updates and best practices to keep the integration of AI tools current and effective.

Notwithstanding, there are challenges to be considered and surpassed; to elaborate further on the issue, state's readiness and careful design of educational policies on a national level are necessary. Furthermore, policy makers, administrations need to adjust national curriculums in such a way that the ethical use of AI is promoted through K-12 education while overreliance to it is avoided.

All things considered, even though the synergy of distance education, STEAM approach and AI technology brings significant benefits, it requires careful attention to its demanding tasks such as data privacy, equitable access to technology, AI bias, and ethical guidelines for AI use which follow its implementation in education. To cover all these, successful integration depends on robust instructional design, continuous support services, and teacher training to ensure that all students can thrive (Shabalala,2024). Teachers are the key to proper application of AI technology in the classroom; they need to be highly trained in order to bridge any potential differences in order to provide clear explanations to future questions and doubts.

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