https://journal.ypidathu.or.id/index.php/jete/
P - ISSN: 3025-0668
E - ISSN: 3025-0676

Generative Art and Secondary Education: Impact of Artificial Intelligence Tools on Student Creativity

Galindo-Durán[1] , Alejandro[2]
[1]University of Almeria, Spain
[2]University of Almeria, Spain

Citation: Duran, G., & Alejandro, Alejandro. (2024). Generative Art and Secondary Education: Impact of Artificial Intelligence Tools on Student Creativity. *Journal Emerging Technologies in Education*, *2*(6), 420–433. https://doi.org/10.70177/jete.v2i6.1920

Correspondence:
Galindo Duran,
www.galindoduran.com

Received: Nov 12, 2024
Accepted: Dec 28, 2024
Published: Dec 28, 2024

ABSTRACT

Background. This research analyzes the impact on creativity of different Artificial Intelligence tools applied to secondary education, specifically in the artistic field.

Purpose. This research analyzes the impact on creativity of different Artificial Intelligence tools applied to secondary education, specifically in the artistic field.

Method. Publications comparing traditional methods with AI-based methodologies have been analyzed in detail through statistical analysis.

Results. The results show significant improvements in student creativity, as well as a democratization of art. After obtaining an average positive impact of 0.4893 ($p < 0.001$), and a high degree of heterogeneity ($I^2 = 90.84\%$).

Conclusion. Despite the variety of contexts and methodologies used in each of the articles analyzed, there is an improvement in creativity, critical thinking or problem solving.

KEYWORDS

Artificial Intelligence*; Creativity; Generative Art; Secondary Education*

INTRODUCTION

Didactic strategies in search of offering a better learning experience and impacting areas such as creativity (Andonova et al., 2023), motivation (Daniel et al., 2024 emotional development (Oliveira et al., 2021) or social skills, among others, have gained more strength in recent years thanks to the integration of various emerging technologies applied to the field of education (Criollo-C et al, 2023). Specifically, in the area of artistic expression, as exposed by Fang and Jiang (2024), technologies such as artificial intelligence through generative art, exposed by Bonadio and Lucchi (2019), have generated debates in contemporary art about the validity of AI-produced creations and their impact on traditional artistic practices. Moreover, they provoke a technological revolution in educational projects with multiple benefits (Mittal et al., 2024).

One of the fields that have benefited the most is the development of creativity, demonstrated by Selfa-Sastre et al. (2022) by exposing how the incorporation of digital tools enhances creativity, an essential competence for everyday life (Chavula et al., 2024) so it is of vital importance to

develop these creative skills from primary education, especially in the stage of Secondary Education (Kyritsi & Davis, 2021).

It should be noted that due to the technological advancement that is recently being developed, there is a technological gap between generations mentioned by Szymkowiak et al. (2021), and therefore between teacher-student. However, the effort to transform education by gradually replacing traditional methodologies with more active ones (Fields et al., 2021) and adapted to the current context, forces teachers to constant training and therefore, to apply emerging technologies in the classroom with the multiple benefits that this entails.

For its part, creativity is a key aspect in education, according to several authors such as Hernandez-Torrano and Ibrayeva (2020); Livingston 2010) or Henriksen et al. (2018), the development of creativity at early ages has a positive effect in the short, medium and long term which contributes to the integral development of the student. Davis (1988) exposes how through various didactic strategies numerous cognitive areas can be enhanced although one of the most benefited is creativity when artistic strategies are applied as well as with emerging technologies since it releases the student's ability to develop their full artistic potential regardless of their capacity or ability with traditional media (Rubin, 2012).

The secondary education curriculum itself as discussed by Wyse and Ferrari (2015) includes the importance of developing creativity, critical thinking, and interdisciplinary skills as an integral part of the training. Borg et al. (2023) show how enhancing creativity through technological tools, allows young people to express ideas, emotions and concepts through digital plastic expression, which can further develop their artistic competence as well as their digital competence.

Traditionally, subjects such as plastic, visual and audiovisual education have been in charge of developing plastic activities that promote creativity (Calavia et al., 2021), however, thanks to interdisciplinary projects, co-teaching and active methodologies such as project-based learning, the development of these capabilities has been opened to a huge range of possibilities allowing more subjects to promote these concepts in addition to collaborative work by integrating various areas of knowledge.

Generative art, on the other hand, is a form of artistic creation in which algorithms and computer systems produce works based on parameters predefined by the artist. This type of art, with an exponential growth in recent years, even months, due to the technological explosion of multiple AI tools, combines human and technological creativity to generate infinite possibilities. Among the most widely used tools in scientific research applied to teaching for generative art are platforms such as ChatGPT, Adobe Firefly, DALL-E, Artbreeder and PromeAI.pro, among others (Mittal et al., 2024). All these technological tools work in a similar way, they use neural networks to interpret textual cues and convert them into complex and detailed images. The key to success is not so much in their realism, but in the possibility of generating completely unrealistic images allowing the limits of students' creativity to be explored (Kim, 2024) without the need for advanced technical skills.

The application of the latest technological tools applied to education, enriches the learning experience by allowing to explore new forms of artistic expression, which derives in fostering creativity and experimentation (Bereczki & Kárpáti, 2021). On the other hand, by integrating AI into the learning process, it generates an increase in participation and therefore in students' engagement and enthusiasm (Wang & Li, 2024), which is one of the current challenges that innovative teaching methodologies seek to solve.

However, despite the multiple benefits, Gómez-Trigueros (2023) states that there are still challenges such as the lack of teacher training in the use of these tools, as well as ensuring the ethical and meaningful use of these tools.

Finally, despite the amount of research related to AI, few studies focus on the specific impact of generative art in secondary education, generating a gap representing an opportunity to explore how these technologies can transform teaching by enhancing creativity.

This study proposes to analyze the impact of generative art tools based on artificial intelligence (AI) and their impact in the classroom in relation to the development of creativity in Secondary Education students, comparing these technologies with traditional art teaching methods.

As main objective, the research evaluates the influence of artificial intelligence tools focused on generative art in the development of creativity in pre-university students. In addition, it aims to identify the most relevant characteristics of recent literature on Artificial Intelligence tools focused on generative art or graphic images focused on education, considering aspects such as the geographical and temporal distribution of research, the authors highlighted, the number of publications and the most used keywords, as well as analyzing the sample selection criteria or characteristics of the students involved and the method used for the research.

At the same time, the characteristics of educational interventions with artificial intelligence tools are also studied, analyzing the effectiveness of these tools in the classroom in terms of the development of students' creativity.

To achieve these objectives the research aims to answer the questions of what are the main characteristics of AI-based generative art studies in the educational context, what specific elements of interventions with generative art tools contribute to the development of creativity in students, as well as what evidence supports the use of these tools in comparison with traditional art methods.

RESEARCH METHODOLOGY

The present study performs a meta-analysis to examine previous research that has analyzed the use of Artificial Intelligence tools focused on art and that have been applied in secondary education. The aim is therefore to identify the impact on the development of students' creativity through the use of AI tools.

To define the published studies from recent literature that are part of the analysis, different criteria have been established, such as research that has studied the use of Artificial Intelligence tools applied to educational contexts, studies that have focused only on secondary education or similar levels as well as publications in indexed academic journals or recognized international conferences, and that have evaluated the impact of these tools on students' creativity.

The study sample corresponds to a total of 2143 studies, which met the previously defined criteria. All the studies incorporated come from academic databases such as Scopus, Web of Science, ERIC and Google Scholar.

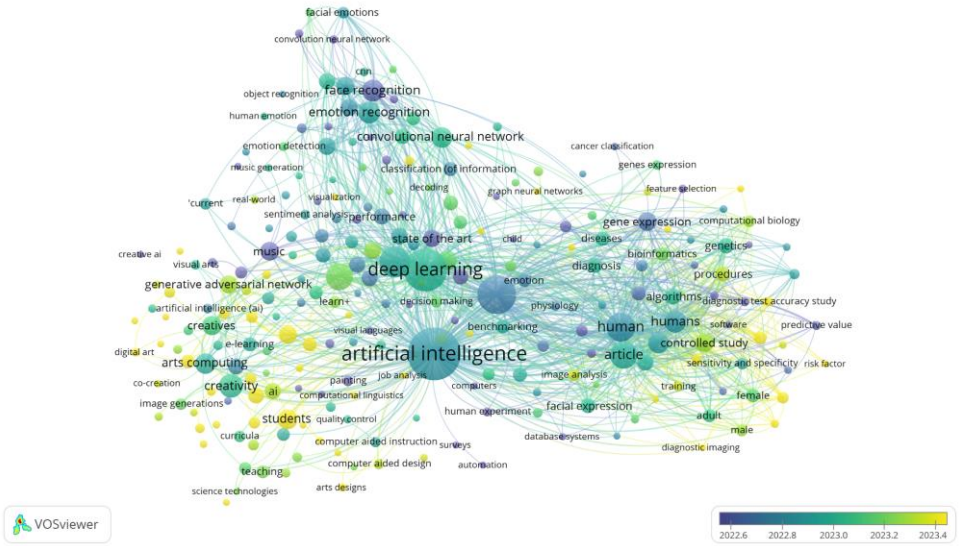
The variables taken into account for the research were: Geographical distribution of the research, year of publication, type of publication (journals, content or books) and the most cited authors. In addition, the keywords used related to artificial intelligence, generative art or creativity were considered. Other parameters taken into account were the type of technological tools analyzed, the duration of the interventions or the educational context. Finally, values corresponding to the results obtained on creativity or motivation were recorded.

A systematic search was carried out in academic reference databases, using terms included in ERIC thesauri, European Thesaurus and European Education Thesaurus and similar terms such as “generative art”, “artificial intelligence in education”, “visual creativity” and “AI tools in art”. Once

all the research was obtained, a selection was made according to the previously defined parameters in order to proceed to the analysis of the studies using statistical and qualitative methods to identify patterns in the results, compare the most effective characteristics of the tools used and evaluate the differences between AI interventions and traditional artistic methods.

With the first search in Scopus whose text was TITLE-ABS-KEY (("arte" OR "art" OR "artístico" OR "artistic" OR "arte digital" OR "digital art" OR "arte generativo" OR "generative art") AND ("inteligencia artificial" OR "AI" OR "artificial intelligence") AND ("creatividad" OR "creativity" OR "expresión artística" OR "artistic expression" OR "visual creativity" OR "creatividad visual" OR "imaginación" OR "imagination" OR "innovación artística" OR "artistic innovation" OR "innovation" OR "innovación") AND ("educación" OR "education" OR "teaching" OR "learning" OR "educación artística" OR "artistic education" OR "educación creativa" OR "creative education" OR "educación secundaria" OR "secondary education" OR "high school" OR "middle school" OR "secundaria" OR "enseñanza secundaria" OR "secondary teaching")) AND PUBYEAR > 2020 AND PUBYEAR < 2026 AND (LIMIT-TO (DOCTYPE,"cp") OR LIMIT-TO (DOCTYPE,"ar") OR LIMIT-TO (DOCTYPE,"ch")), a total of 575 studies and publications were obtained, making a bibliographic diagram with the key words to visit the distribution and relationship between them.

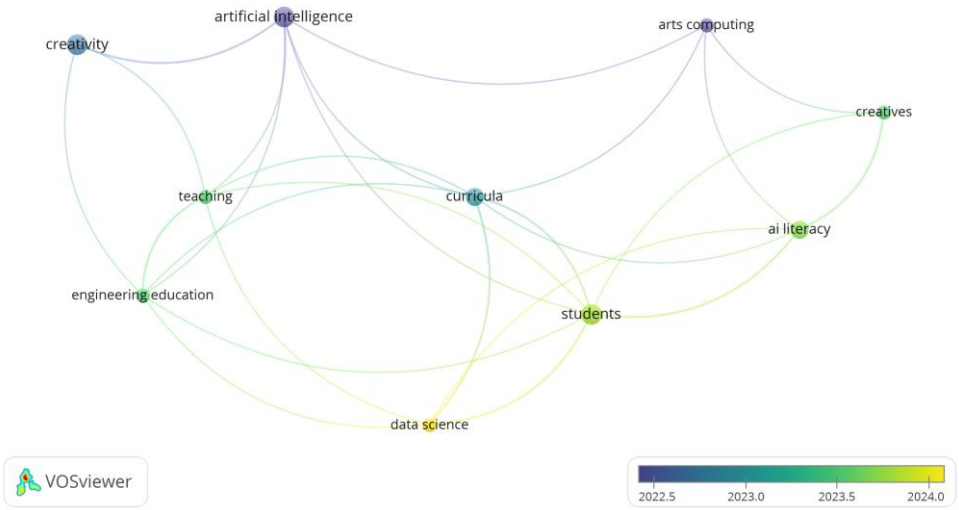
Figure 1.
Biometric Study



By defining your search specifically to secondary education in Scopus using this search string TITLE-ABS-KEY (("arte" OR "art" OR "artístico" OR "artistic" OR "arte digital" OR "digital art" OR "arte generativo" OR "generative art") AND ("inteligencia artificial" OR "AI" OR "artificial intelligence") AND ("creatividad" OR "creativity" OR "expresión artística" OR "artistic expression" OR "visual creativity" OR "creatividad visual" OR "imaginación" OR "imagination" OR "innovación artística" OR "artistic innovation" OR "innovation" OR "innovación") AND ("educación" OR "education" OR "teaching" OR "learning" OR "educación artística" OR "artistic education" OR "educación creativa" OR "creative education") AND ("educación secundaria" OR "secondary education" OR "high school" OR "middle school" OR "secundaria" OR "enseñanza secundaria" OR "secondary teaching")) AND PUBYEAR > 2020 AND PUBYEAR < 2026 AND (

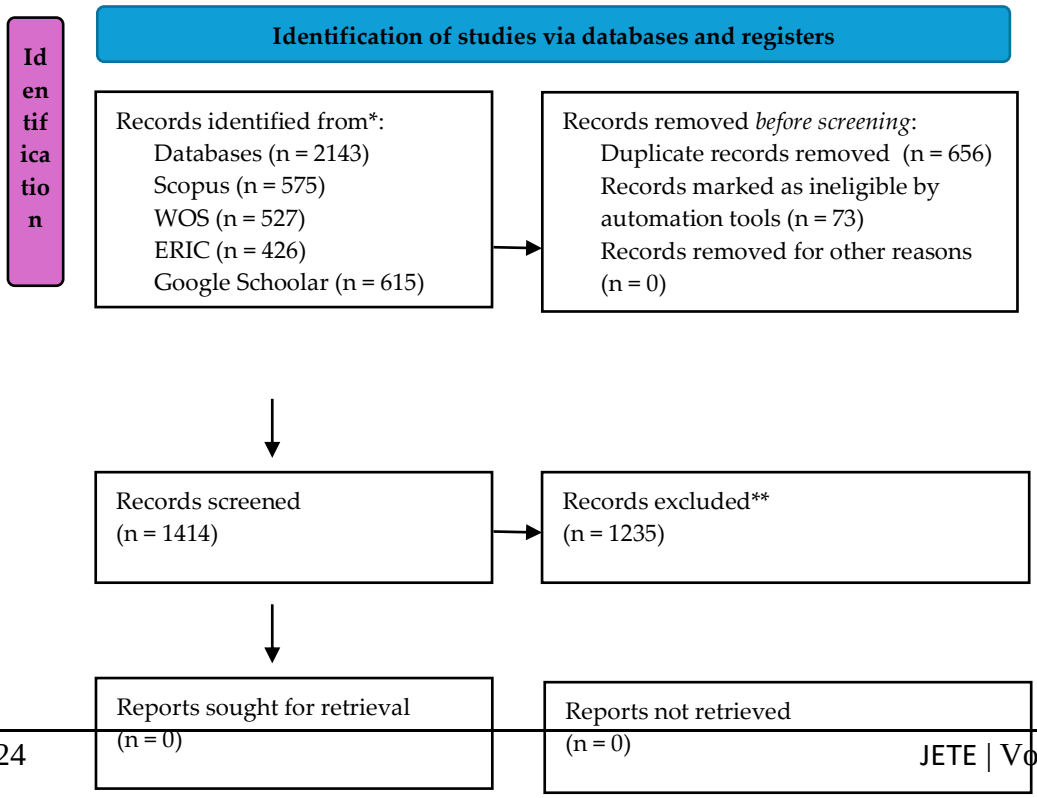
LIMIT-TO (DOCTYPE,"cp") OR LIMIT-TO (DOCTYPE,"ar") OR LIMIT-TO (DOCTYPE,"ch")), only 10 studies were obtained with a bibliometric scheme as shown in Figure 2, which is not very representative.

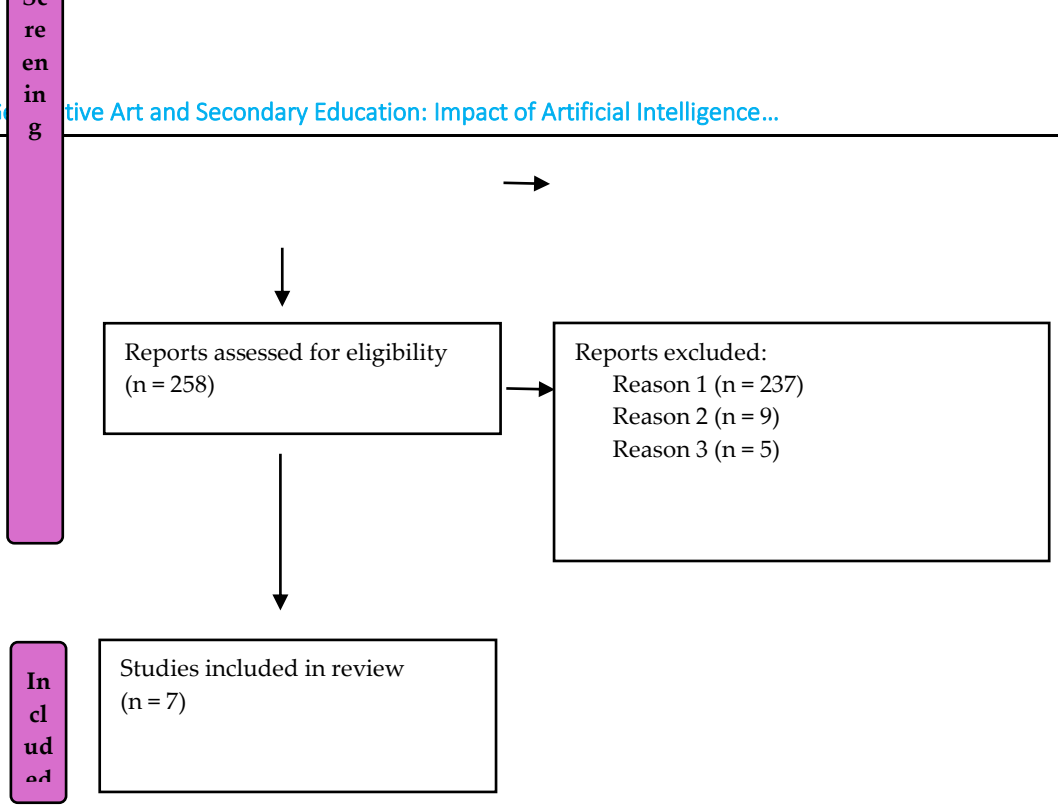
Figure 2.
Reduced Biometric Study



In addition, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guide was followed to standardize the analysis, ensure completeness and rigor and improve the credibility of the results (Abelha et al, 2020) obtaining a flow chart (Figure 3) for new systematic reviews that included searches only in databases and registries with the following structure.

Figure 3.
Scheme According to PRISMA Guide





Based on the 258 results, inclusion and exclusion criteria were applied to the articles based on 3 criteria. The first criterion for analyzing the studies is that they should be classroom experiences. The second criterion filters out those didactic activities that have been applied in secondary education or equivalent levels, and finally, the third criterion is that they must have a control group and an experimental group measuring creativity with quantitative or qualitative parameters based on academic performance or similar in order to establish a comparison between the articles. After applying these criteria, 7 scientific articles were obtained that have served to analyze the impact of AI tools in fostering creativity.

To carry out an exhaustive analysis of the effects model with the data collected from the various studies, we had to extrapolate some of the values of each article, with a maximum of 2 values per article, according to logical criteria, with academic rigor, locating similar values in related publications to maintain consistency. The parameters that had to be completed were in the fields of sample size, Mean, Confidence Interval (CI), p-value or t-value. This exercise of interpreting data that did not exist in each of the reference articles made it possible to homogenize the results, as well as to ensure the consistency of the existing literature in order to answer the questions of this research.

RESULT AND DISCUSSION

For the analysis of the impact of artificial intelligence on students' creativity, it has been structured in two main analyses, the first of which deals with the main publications published in high-impact academic journals arising from the application of the various criteria according to the PRISMA guide. The second part of the results is a specific analysis of the impact of these technologies on creativity.

Of the more than 1400 articles obtained from the main scientific article publication databases after applying the first filters, and after applying the various criteria specified above, only seven were feasible for this study, which shows that this is a field that needs to be studied in depth. Table 1 shows the articles identifying the journal, its impact factor (IF) and quartile (Q), as well as the sample size (n) and the parameters measured in the study, generally creativity.

Art 1. Can educational robots improve student creativity: A meta-analysis based on 48 experimental and quasi-experimental studies. Autores: Hou, H. et al. (2022).

Art 2. Effect of Artificial Intelligence on One-to-One Emotional Regulation and Psychological Intervention System of Middle School Students. Autores: Wang, E. et al. (2022).

Art 3. Impact of Artificial Intelligence-based Learning Process on Students' Tendency to Involve in Independent Research at the Higher Secondary School. Autores: Mazedul M. et al. (2023).

Art 4. Potenciando el aprendizaje activo interdisciplinar con inteligencia artificial en aulas digitales en EGB. Autores: Ortiz, L. et al., (2024).

Art 5. Research on the Influence of AI and VR Technology for Students' Concentration and Creativity. Autores: Rong, Q. et al. (2022).

Art 6. The impact of educational robots on students' computational thinking: A meta-analysis of K-12. Autores: Hong, L. (2024).

Art 7. Embracing Artificial Intelligence in the Arts Classroom: Understanding Student Perceptions and Emotional Reactions to AI Tools. Autores: Grájeda, A. et al. (2024).

Table 1.
Item Details

Article	Journal	Q	FI	n	Measured Parameters
Hou et al. (2022)	Best Evidence in Chinese Education	-	-	6057	Creativity, innovation, teaching
Wang et al. (2022)	International Journal of Neuropsychopharmacology	Q1 JCR, Q1 SJR	4.5	76	Psychological aspects
Mazedul et al. (2023)	International Journal on Recent and Innovation Trends in Computing and Communication	Q4 SJR	0.71	950	Self-efficacy, subjective norms, attitudes towards AI
Ortiz et al. (2024)	PolodelConocimiento	-	-	145	Creativity, critical thinking, personalization
Rong et al. (2022)	Frontiers in Psychology	Q1 JCR, Q2 SJR	2.6	48	Concentration, creativity, anxiety levels
Hong (2024)	Education and Information Technologies	Q1 JCR, Q1 SJR	4.8	1500	Computational thinking, creativity, teamwork, critical skills
Grájeda et al. (2024)	Cogent Education	Q2 JCR, Q2 SJR	1.5	794	Student perceptions, emotional reactions, usefulness of AI tools, satisfaction

As can be seen, the publications are focused on the implementation of artificial intelligence tools in secondary education, specifically in the artistic field, although there are publications in adjacent areas. Among the studies, there are publications that address the impact on creativity, improvement of learning, how it affects critical thinking or emotional reactions of students to this technology. Of particular note is the meta-analysis with a large sample of more than 6000 participants on the use of educational robots and how they significantly enhance creativity and innovation. The most relevant aspect of these seven articles is that they all show a significant improvement in the different parameters evaluated due to the use of artificial intelligence in the classroom. Other studies stand out for their analysis of students' perception of the artificial intelligence tool and how they can foster curiosity for learning and thus their creativity. Although the sample sizes and contexts vary among all the articles, there are similar conclusions in highlighting how these technologies enrich the educational experience and foster various skills such as creativity or critical thinking, among others.

Impact of Artificial Intelligence on creativity.

The analysis of how creativity is influenced by the use of Artificial Intelligence tools focused on art has been one of the fastest growing research topics in recent years, however, few studies have analyzed its impact on pre-university students. Therefore, this analysis examines how the incorporation of these technologies directly influences the creative ability of students through articles that have addressed this topic with experimental and control groups.

Table 2 shows a summary of the scientific articles used in the statistical analysis, highlighting their main characteristics, such as sample size, means obtained in the experimental and control groups, confidence intervals (CI), p and t values. This analysis allows us to identify significant differences between interventions based on artificial intelligence tools and traditional artistic methods.

Table 2.
Articles Analyzed for the Statistical Study

Article	Sample size	Mean (Exp.)	Mean (Ctrl.)	Confidence Interval (CI)	p-value	t-value
Hou et al. (2022)	6057	8.5	7.8	[0.4 ; 0.7]	0.001	8.5
Wang et al. (2022)	76	9.1	8.4	[1.23 ; 7.96]	0.045	2.05
Mazedul et al. (2023)	950	8.98	8.5	[0.4 ; 0.8]	0.051	7.994
Ortiz et al. (2024)	145	8	6.5	[0.8 ; 1.6]	0.002	3.2
Rong et al. (2022)	48	8.58	8.06	[0.1 ; 0.7]	0.001	3.2
Hong (2024)	1500	8.2	7.5	[0.419 ; 0.697]	0	7.851
Grájeda et al. (2024)	794	6.06	5.884	[0.1 ; 0.3]	0.05	1.96

The results show that all the studies included in this analysis show a positive effect between the experimental group and the common group by obtaining higher scores, which suggests that the implementation of Artificial Intelligence tools contributes significantly to the development of creativity. Likewise, most of the p-values reported are statistically significant with the exception of

one of them with a value of 0.051, although it is not in the borderline range, it is quite close to that value.

On the other hand, Table 3 shows the random effects model providing an overall estimate of the impact of these tools on creativity taking into account the variability among the selected studies, this statistical analysis is especially useful in contexts where there is heterogeneity in sample size.

Table 3.

Random-Effects Model (k = 7)

k	Estimate	SE	Z	p	CI Lower Bound	CI Upper Bound
7	0.4893	0.0226	21.6386	0.0000	0.4450	0.5336

Nota: Tau² Estimator (Restricted Maximum-Likelihood)

The most relevant results of this analysis show a mean impact estimate of 0.4893, with a narrow confidence interval with little margin (0.4450 - 0.5336), and an extremely significant p-value ($p < 0.0001$). This indicates significant and solvent results. Furthermore, the standard deviation of 0.0226 reinforces the reliability of this estimate. These results suggest that, regardless of the differences between studies, the positive impact of AI tools on creativity is significant and generalizable.

To analyze between-study variation, we performed the heterogeneity statistic, Table 4, including metrics such as Tau², I² and Q-value to assess the consistency of the results and determine whether the observed variability is attributable to real differences between studies or to random factors.

Table 4.

Heterogeneity Statistics

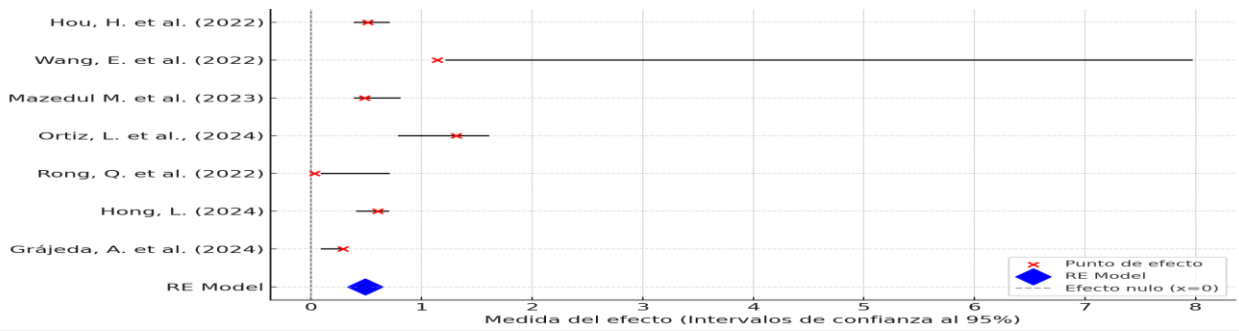
Tau	Tau²	I²	H²	df	Q	p	Prediction interval min	Prediction interval max
0.192	0.036	90.840	10.917	6	65.51	0.0000	0.248	1.001

The results indicate moderate heterogeneity by obtaining a value of $I^2 = 90.84\%$, suggesting variation between studies, but within an acceptable range for a meta-analysis. The Q value (65.51, $p < 0.0001$) confirms the planted heterogeneity being statistically significant. These values allow valid and representative conclusions of the overall impact.

In addition, the Forest plot has been represented in Figure 4 to visualize the results of each study and its contribution to the estimated overall effect in order to easily identify the weight of each study and the consistency of the results.

Figure 4.

Forest Plot



The Forest plot shows that all the studies present positive effects, with confidence intervals that do not cross the no effect line. These results reinforce the consistency and validate the hypothesis that AI tools have a positive and significant impact on students' creativity. Although there are slightly varying effect sizes, the positive direction of the impact is clear in all cases.

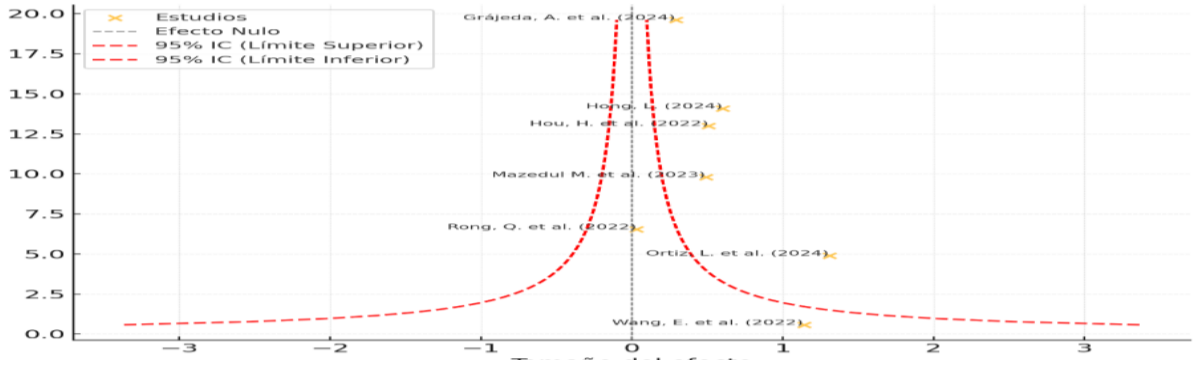
On the other hand, to assess whether the results may be influenced by the lack of inclusion of studies with negative or non-significant results, a publication bias was performed in Table 5. For this purpose, several statistical tests, such as Egger's Test and the Trim and Fill Test, were used to ensure the robustness of the analysis.

Table 5.
Publication Bias Assessment

Test Name	value	p
Fail-Safe N	153.53	
Begg and Mazumdar Rank Correlation	0.24	0.56
Egger's Regression	1.02	0.02
Trim and Fill Number of Studies	1.00	

The results suggest a low risk of publication bias. Although Egger's test indicates a slight asymmetry (p = 0.02), the Begg and Mazumdar test did not detect significant correlations (p = 0.56). Furthermore, the Trim and Fill analysis suggests that the addition of a single study would not significantly alter the conclusions, implying that the results are reliable and not biased by omission of relevant research. Likewise, the distribution of effect sizes, Figure 5, as a function of their precision is plotted to detect possible asymmetries that could indicate publication bias.

Figure 5.
Funnel Plot



The Funnel plot presents a relatively symmetrical distribution, with most of the points located near the central axis, although a slight asymmetry is observed at the base of the plot. Overall, the plot supports the conclusion that publication bias is minimal and does not significantly affect the validity of the results.

CONCLUSION

The impact of AI tools on the creativity of high school students has been analyzed by this research through a meta-analysis on multiple recent investigations, obtaining relevant results that

provide the field of education with a space to work on and investigate, as a positive impact on creativity has been seen thanks to these emerging technologies.

The results obtained from recent literature confirm that integrating AI tools in education fosters creativity, among other aspects. The means observed in both experimental and control groups show that there are significant differences between the two. In addition, it is shown that the use of these tools does not require specific artistic knowledge or skills, which democratizes access to creative processes, allowing students with different abilities to participate actively.

The analysis of the different published studies reveals a great diversity both in methodological approaches and in their purposes, since some of them focus on perception or motivation, sharing among them the analysis of creativity, this diversity shows the richness of the field and the variety of benefits that AI tools can bring to the educational field. It should be noted, therefore, that this heterogeneity underscores the need to establish more uniform methodological standards for future research.

It has been demonstrated through this analysis, using the models employed, that although there is variability across studies, the overall effect of AI tools on creativity is significant. Likewise, the low risk of publication bias supports the validity of the results obtained, justifying that the use of AI tools enhances artistic creativity, which combined with other key skills developed such as critical thinking, problem solving or collaboration allows working in interdisciplinary projects, exploring connections between different areas of knowledge with better performances. These results underline the transformative potential of AI both in the artistic field and in education in pre-university stages.

Finally, due to the growing interest in the use of AI in education, this research locates a gap in the literature related to specific studies on the impact of generative art in secondary education, given that most research focuses on general educational contexts or higher levels, This highlights the need for more focused studies on high school students, a key cognitive stage of students' development, so it is recommended that future researchers analyze the impact of AI at younger ages as the progressive integration of AI tools focused on generative art in secondary education programs is recommended.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing; Conceptualization; Data curation; In-vestigation; Data curation; Investigation; Formal analysis; Methodology; Writing - original draft.

Author 2: Supervision; Validation; Other contribution; Resources; Visuali-zation; Writing - original draft.

REFERENCES

Abelha, M., Fernandes, S., Mesquita, D., Seabra, F., & Ferreira-Oliveira, A. T. (2020). Graduate Employability and Competence Development in Higher Education—A Systematic Literature Review Using PRISMA. *Sustainability*, *12*(15), 5900. https://doi.org/10.3390/su12155900

Andonova, V., Reinoso-Carvalho, F., Jimenez Ramirez, M. A., & Carrasquilla, D. (2023). Does multisensory stimulation with virtual reality (VR) and smell improve learning? An educational experience in recall and creativity. *Frontiers in Psychology*, *14*. https://doi.org/10.3389/fpsyg.2023.1176697

Bereczki, E. O., & Kárpáti, A. (2021). Technology-enhanced creativity: A multiple case study of digital technology-integration expert teachers' beliefs and practices. *Thinking Skills and Creativity*, *39*, 100791. https://doi.org/10.1016/j.tsc.2021.100791

Bonadio, E., & Lucchi, N. (2019). How Far Can Copyright Be Stretched? Framing the Debate on Whether New and Different Forms of Creativity Can Be Protected. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3495223

Borg Preca, C., Baldacchino, L., Briguglio, M., & Mangion, M. (2023). Are STEM Students Creative Thinkers? *Journal of Intelligence*, *11*(6), 106. https://doi.org/10.3390/jintelligence11060106

Calavia, M. B., Blanco, T., & Casas, R. (2021). Fostering creativity as a problem-solving competence through design: Think-Create-Learn, a tool for teachers. *Thinking Skills and Creativity*, *39*, 100761. https://doi.org/10.1016/j.tsc.2020.100761

Chavula, C., Choi, Y., & Rieh, S. Y. (2024). Searching for creativity: How people search to generate new ideas. *Journal of the Association for Information Science and Technology*, *75*(4), 438–453. https://doi.org/10.1002/asi.24857

Criollo-C, S., Govea, J., Játiva, W., Pierrottet, J., Guerrero-Arias, A., Jaramillo-Alcázar, Á., & Luján-Mora, S. (2023). Towards the Integration of Emerging Technologies as Support for the Teaching and Learning Model in Higher Education. *Sustainability*, *15*(7), 6055. https://doi.org/10.3390/su15076055

Daniel, K., Msambwa, M. M., Antony, F., & Wan, X. (2024). Motivate students for better academic achievement: A systematic review of blended innovative teaching and its impact on learning. *Computer Applications in Engineering Education*, *32*(4). https://doi.org/10.1002/cae.22733

Davis, A. R. (1988). Developing Teaching Strategies Based on New Knowledge. *Journal of Nursing Education*, *27*(4), 156–160. https://doi.org/10.3928/0148-4834-19880401-05

Fang, F., & Jiang, X. (2024). The Analysis of Artificial Intelligence Digital Technology in Art Education Under the Internet of Things. *IEEE Access*, *12*, 22928–22937. https://doi.org/10.1109/ACCESS.2024.3363655

Fields, L., Trostian, B., Moroney, T., & Dean, B. A. (2021). Active learning pedagogy transformation: A whole-of-school approach to person-centred teaching and nursing graduates. *Nurse Education in Practice*, *53*, 103051. https://doi.org/10.1016/j.nepr.2021.103051

Gómez-Trigueros, I. M. (2023). Digital skills and ethical knowledge of teachers with TPACK in higher education. *Contemporary Educational Technology*, *15*(2), ep406. https://doi.org/10.30935/cedtech/12874

Grájeda, A., Córdova, P., Córdova, J. P., Laguna-Tapia, A., Burgos, J., Rodríguez, L., Arandia, M., & Sanjinés, A. (2024). Embracing artificial intelligence in the arts classroom: understanding student perceptions and emotional reactions to AI tools. *Cogent Education*, *11*(1). https://doi.org/10.1080/2331186X.2024.2378271

Henriksen, D., Henderson, M., Creely, E., Ceretkova, S., Černochová, M., Sendova, E., Sointu, E. T., & Tienken, C. H. (2018). Creativity and Technology in Education: An International Perspective. *Technology, Knowledge and Learning*, *23*(3), 409–424. https://doi.org/10.1007/s10758-018-9380-1

Hernández-Torrano, D., & Ibrayeva, L. (2020). Creativity and education: A bibliometric mapping of the research literature (1975–2019). *Thinking Skills and Creativity*, *35*, 100625. https://doi.org/10.1016/j.tsc.2019.100625

Hong, L. (2024). The impact of educational robots on students' computational thinking: A meta-analysis of K-12. *Education and Information Technologies*, *29*(11), 13813–13838. https://doi.org/10.1007/s10639-023-12415-y

Hou, H., Zhang, X., & Wang, D. (2022). Can Educational Robots Improve Student Creativity: A Meta-analysis based on 48 Experimental and Quasi-experimental Studies. *Best Evidence in Chinese Education*, *11*(1), 1449–1454. https://doi.org/10.15354/bece.22.ab001

Kim, S. J. (2024). Generative Artificial Intelligence in Collaborative Ideation: Educational Insight From Fashion Students. *IEEE Access*, *12*, 49261–49274. https://doi.org/10.1109/ACCESS.2024.3382194

Kyritsi, K., & Davis, J. M. (2021). Creativity in primary schools: An analysis of a teacher's attempt to foster childhood creativity within the context of the Scottish Curriculum for Excellence. *Improving Schools*, *24*(1), 47–61. https://doi.org/10.1177/1365480220968332

Livingston, L. (2010). Teaching Creativity in Higher Education. *Arts Education Policy Review*, *111*(2), 59–62. https://doi.org/10.1080/10632910903455884

Mazedul, M., Talukdar, H., Rhama, E., & Saeed, O. (2023). Impact of Artificial Intelligence based Learning Process on Students' Tendency to Involve in Independent Research at the Higher Secondary School. *International Journal on Recent and Innovation Trends in Computing and Communication*, *11*(9), 4378–4384. https://doi.org/10.17762/ijritcc.v11i9.9924

Mittal, U., Sai, S., Chamola, V., & Sangwan, D. (2024). A Comprehensive Review on Generative AI for Education. *IEEE Access*, *12*, 142733–142759. https://doi.org/10.1109/ACCESS.2024.3468368

Oliveira, S., Roberto, M. S., Pereira, N. S., Marques-Pinto, A., & Veiga-Simão, A. M. (2021). Impacts of Social and Emotional Learning Interventions for Teachers on Teachers' Outcomes: A Systematic Review With Meta-Analysis. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.677217

Ortiz, L. A. O., González, K. M. A., Velarde, Z. B. J., & Naranjo, S. G. C. (2024). Potenciando el aprendizaje activo interdisciplinar con inteligencia artificial en aulas digitales en EGB. *Polo Del Conocimiento*, *9*(9), 1211–1231.

Rong, Q., Lian, Q., & Tang, T. (2022). Research on the Influence of AI and VR Technology for Students' Concentration and Creativity. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.767689

Rubin, J. (2012). Technology's Impact on the Creative Potential of Youth. *Creativity Research Journal*, *24*(2–3), 252–256. https://doi.org/10.1080/10400419.2012.677370

Selfa-Sastre, M., Pifarré, M., Cujba, A., Cutillas, L., & Falguera, E. (2022). The Role of Digital Technologies to Promote Collaborative Creativity in Language Education. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.828981

Szymkowiak, A., Melović, B., Dabić, M., Jeganathan, K., & Kundi, G. S. (2021). Information technology and Gen Z: The role of teachers, the internet, and technology in the education of young people. *Technology in Society*, *65*, 101565. https://doi.org/10.1016/j.techsoc.2021.101565

Wang, E., Chang, W.-L., Shen, J., Bian, Q., Huang, P., Lai, X., Chang, T.-Y., Shaoying, H., Ziyue, Z., Wang, Z., Xue, H., & Kues, S. (2022). Effect of artificial intelligence on one-to-one emotional regulation and psychological intervention system of middle school students. *International Journal of Neuropsychopharmacology*, *25*(Supplement_1), A62–A63. https://doi.org/10.1093/ijnp/pyac032.086

Wang, L., & Li, W. (2024). The Impact of AI Usage on University Students' Willingness for Autonomous Learning. *Behavioral Sciences*, *14*(10), 956. https://doi.org/10.3390/bs14100956

Wyse, D., & Ferrari, A. (2015). Creativity and education: comparing the national curricula of the states of the European Union and the United Kingdom. *British Educational Research Journal*, *41*(1), 30–47. https://doi.org/10.1002/berj.3135