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Interventions to increase creativity in the 21st century: a scoping review

Intervenções para aumentar criatividade no século XXI: uma revisão de escopo

Intervenciones para aumentar la creatividad en el siglo XXI: una revisión del alcance

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Highlights

Scientific research on interventions to increase creativity shows a strong upward trend.

Teachers and students in educational settings appear to be the primary targets of interventions.

Collaborative networks among different groups of authors remain limited.

Abstract

To analyze scientific literature on interventions to increase creativity, a scoping review was conducted following the PRISMA-ScR guidelines. Empirical research articles published between 2000 and 2022 in English, Portuguese, or Spanish were retrieved. The 274 texts included were subjected to scientometric analyses based on authorship, year of publication, title, abstract, keywords, and the methods section. There has been a growing trend in publications over time and a geographical distribution of interventions across 50 territories, with the United States and China standing out. A total of 758 authors were identified, of whom only five had four or more articles. The research topics were mainly related to education, teaching methods, cognition, and innovation. Teachers and students in educational settings stood out as the target population and context for the interventions. The results suggest restrictions on collaboration networks between authors, territories, populations, and contexts covered by the interventions.

Resumo | Resumen

Keywords

Creativity. Technology. Scientometrics. Interventions.

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Introduction

Creativity is a fundamental human skill for adapting to new social configurations and dealing with the demands and challenges of the 21st century (Henriksen et al., 2018). Since strategies and technologies have been developed to enhance creativity, this article reviewed research published between 2000 and 2022 that reports on interventions to increase creativity (IAC).

To raise awareness of its role in the development of nations, the United Nations (2017) established April 21 as World Creativity and Innovation Day. In the field of health, creative thinking is one of the ten life skills identified by the World Health Organization (WHO, 1998, 2020) as a resource that promotes adaptive and protective development in human beings. In the field of work, the World Economic Forum (WEF, 2020) highlights that creativity is one of the essential skills for professionals of the future. Similarly, public authorities in several countries recognize the development of creativity as one of the objectives of basic and higher education (e.g., Henriksen et al., 2018; National Congress, 1996; Ministry of Education, 2018; OECD, 2017). However, as Valgeirsdottir and Onarheim (2017) warn, conceptual ambiguities and theoretical and practical inaccuracies hinder the advancement of strategies and technologies to translate these objectives into practice.

Historically, the study of creativity has been marked by ontological and epistemological plurality, the practical implications of which are manifested in the heterogeneity of research and intervention methods and contexts (Kaufman & Glăveanu, 2019). Kampylis and Valtanen (2010) analyzed 42 definitions and, converging with Rhodes' (1961) classic conceptualization, identified four main aspects: (1) a key skill of the individual (person); (2) that presupposes some intentional activity (process); (3) and happens contextually (environment); (4) allowing the generation of a product that is considered new and appropriate. The understanding of creativity in terms of originality and usefulness is what seems to generate the most consensus among researchers. However, there are disputes regarding its operationalization (Runco & Jaeger, 2012) and the universalization of these dimensions (Glăveanu, 2019).

Since the 1980s, the science of creativity has focused on the role of cognitive, motivational, affective, personality, and environmental factors (Alencar & Fleith, 2009; Neves-Pereira & Fleith, 2020). Over the past three decades, there has been an increase in interest in creativity in everyday life (Villanova & Cunha, 2021) and in cross-cultural discussions (Glăveanu, 2019). From a developmental perspective (Penagos-Corzo, 2018), it is accepted that, at any point in life, an individual's creative performance results from a complex combination of beneficial and deleterious influences arising from their interactions with their immediate and mediate environments (Barbot et al., 2016). Furthermore, interventions can increase creative potential in any age group and promote increased creative performance in various contexts (Hui et al., 2019).

In addition to corroborating the idea that creative competence can be increased (e.g., Rose & Lin, 1984), research has shown that its increase can favor other variables related to positive development (e.g., Chen & Padilla, 2019; Nakano et al., 2021). To synthesize evidence from existing IACs, several systematic reviews have already been conducted: some focused on creativity training programs with adults (Scott et al., 2004; Ma, 2006; Valgeirsdottir & Onarheim, 2017), while others addressed interventions with children (Alves-Oliveira et al., 2022; Ruiz-del-Pino et al., 2022). More recently, Kotz and Formiga-Sobrinho (2023) reviewed studies on the promotion of scientific creativity in adolescents. As they aim to analyze the results of interventions, these systematic reviews adopted inclusion criteria restricted to experimental studies (*"hard science"*) or studies with specific methodological characteristics.

Broadening the scope, there are systematic reviews on other aspects of creativity, such as its measurement in children (Kupers et al., 2019), adolescents (van der Zanden, 2020), and undergraduate students (Snyder et al., 2019). These, in turn, encompass empirical studies with different objectives, without being restricted exclusively to interventions.

From an even broader perspective, scientometric mapping studies have examined the body of research on creativity, using techniques to quantify and analyze patterns in scientific literature. For example, Long et al. (2014) analyzed productivity and scientific performance in creativity between 1965 and 2012. To this end, they considered the publications, citations, and impact factors of four high-visibility journals. Williams et al. (2016) mapped the themes, impact, and cohesion of research from 1990 to 2015. Using computational methods, this study performed textual and network analyses based on keywords from the retrieved publications. Hernández-Torrano and Ibrayeva (2020) retrieved articles from 1975 to 2019 on creativity and education to analyze: year and journal of publication; authors, their institutions, and countries; keywords, titles, and abstracts. Studies of this nature are relevant because they allow us to identify historical trends, map collaboration networks, and point out gaps in a given field of study (Li et al., 2021). However, no specific scientometric mappings on IAC have been found to date.

Given that creativity is considered a key competency for the 21st century. Still, there is a lack of comprehensive reviews on IAC. This text presents a scoping review of research published between 2000 and 2022 that reports on these interventions. Specifically, the objectives were: to analyze publication timing; to describe the geographical distribution of these interventions; to identify the main researchers and scientific collaboration networks; to analyze the thematic focus of the research; and to describe the main populations and contexts covered. Unlike the systematic reviews on IAC mentioned above, this study advocates a molar view, through scientometric mapping. Therefore, this text does not discuss the specifics and results of IACs, but rather the general characteristics of the body of research on the subject.

Method

A scoping review (Munn et al., 2022) was conducted based on the PRISMA-ScR (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) guidelines (Tricco et al., 2018). One of the sources of information used was the CAPES[1] Journal Portal search engine, which offers an extensive collection of databases. The Web of Science[2] and Scopus[3] databases were also consulted, as well as the PsycNET[4] system, which covers the PsycINFO and PsycArticles databases. To minimize false negatives, all articles included in the systematic reviews by Scott et al. (2004), Ma (2006), Valgeirsdottir and Onarheim (2017), and Alves-Oliveira et al. (2022) were also considered.

The following combination of descriptors was used: "creativity AND training" OR "'divergent thinking' AND training" OR "'creative thinking' AND training" OR "enhancing creativity" OR "applied creativity" OR "development of creative capacities" OR "development of creativity" OR "improving creativity" OR "fostering creativity" OR "creativity gym" OR "creativity course" OR "creativity program" OR "creativity AND stimulation" OR "creativity AND promotion" OR "creativity AND intervention". These terms were defined based on both a review of the literature and descriptors used in other reviews (e.g., Valgeirsdottir & Onarheim, 2017). The descriptors were searched exclusively in English in the titles, keywords, and abstracts. Time-delimiting filters were used to identify only literature from the 21st century (2000 to 2022).

The following were included: scientific articles (A) from empirical research based on primary data (B), with full texts published in English, Portuguese, or Spanish (C), on interventions (D) aimed at increasing participants' creativity (E). Publications whose full texts were not available for free online were excluded.

It was restricted to publications of empirical research (criterion B) in scientific articles (criterion A), since they offer greater control over biases and the quality of the knowledge produced, in addition to being the most democratic and widespread form of scientific communication. The linguistic restriction (criterion C) was due to English being the common language of science and to the researchers' affinity for other languages. Criteria (D) and (E) relate to the concept (Peters et al., 2015) adopted in this review, i.e., IAC. Any environmental change produced intentionally, in a more or less planned manner, with the aim of increasing the creative potential or performance of one or more people was considered an intervention.

The searches took place between April and June 2022. After eliminating duplicates, bibliometric data (title, abstract, author(s), keywords, year of publication) were extracted, and initial screening was performed by reading titles and abstracts. The selected articles were read in full to verify eligibility and the location of the

1 Available at: https://www.periodicos.capes.gov.br/

2 Available at: https://www.webofscience.com

3 Available at: https://www.scopus.com/

4 Available at: https://psycnet.apa.org/

interventions. The screening was performed by one author and reviewed by two peers, obtaining a concordance rate (92%) higher than what has been established as the concordance rate among judges (80%).

For the analysis and presentation of results, scientometric approaches were adopted (Li et al., 2021). For temporality, the number of publications per year was calculated, and a trend line was estimated based on this calculation. For the trend line, 2021 was excluded due to the atypical conditions of the COVID-19 pandemic, and 2022 was excluded because it is still ongoing. Geographic distribution was described according to the frequency of countries in which IACs were implemented and the territorial arguments suggested by the United Nations[5].

For other analyses, the VOSViewer[6] software was used, which generates network maps with nodes representing objects of interest (such as authors and keywords) and lines indicating the connections between them. The nodes are organized into clusters; their sizes reflect the frequency of the items, while their colors indicate the clusters, and the line thickness indicates the strength of the connections. The results are presented through maps and numerical values for occurrence (o), links (lg), link strength (flg), and average publication year (ma). A relevance index (RI) was also calculated for each term/keyword by multiplying o, lg, and flg.

To examine leading researchers and scientific collaborations, a co-authorship analysis was performed, with equal weight given to all authors, and the data were pre-processed to correct for name variations. Titles, abstracts, and keywords were analyzed for co-occurrence, excluding terms used as search descriptors. The keywords were used to analyze the main thematic focuses of the research, and their temporal trends were compared using analysis of variance (F), with a significance level of 5%. It should be added that the T-test for a sample was also used with this same resampling procedure and with the same level of significance.

Results

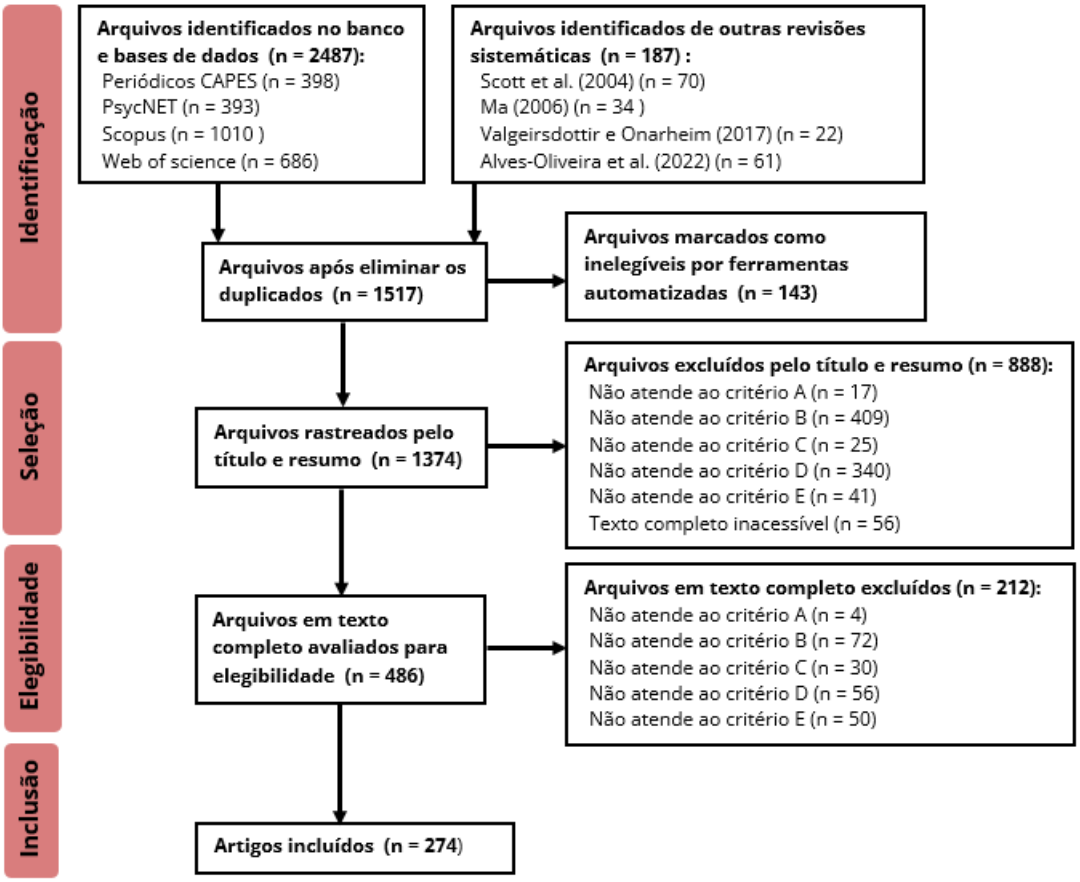
The search process resulted in 2,674 publications, of which 2,487 (93.01%) were from information systems and databases, and 187 (6.99%) were from systematic reviews consulted (Figure 1). Of the total number of publications, 1,157 (43.27%) were duplicates and were disregarded. Among the remaining (n = 1,517; 56.73%), 143 (9.43%) were identified as ineligible when examined in the reference management software, as they were conference files (n = 6; 0.40%), book chapters (n = 4; 0.26%), retracted articles (n = 2; 0.13%), or published outside the time frame researched (n = 131; 8.64%). The titles and abstracts of the remaining articles were read and judged according to the inclusion criteria, resulting in 888 (64.63%) articles excluded and 486 (35.37%) articles selected for evaluation according to eligibility. After reading the full text and screening according to the inclusion and exclusion criteria, 212 (43.62%) articles were excluded. Thus, the final sample of

5 Available at: https://unstats.un.org/unsd/methodology/m49/

6 Available at: https://www.vosviewer.com

publications included in this review consisted of 274 articles, accounting for slightly more than one-tenth (10.25%) of the total number of articles initially[7] considered.

Figure 1
Data collection flowchart according to PRISMA



Note: Criterion A**:** scientific articles; Criterion B: empirical research based on primary data; Criterion C: published in English, Portuguese, or Spanish; Criterion D: reports one or more interventions; Criterion E: aimed to increase participants' creativity.
Source: the authors.

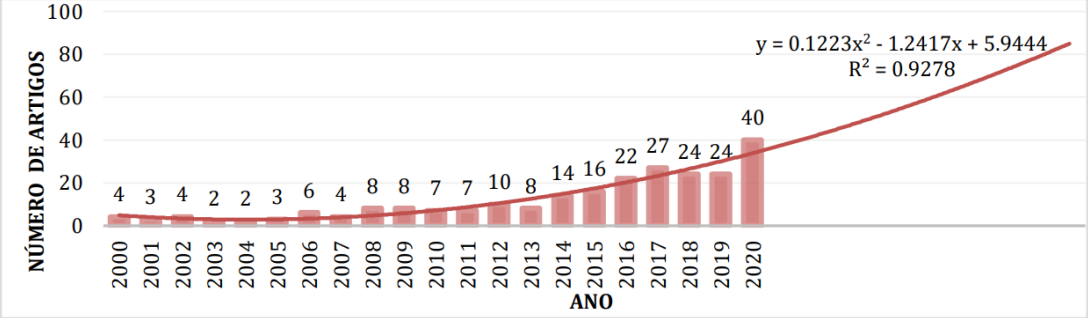
In analyzing the temporality of publications, 243 articles were considered, and their distribution is shown in Figure 2. The average number of articles per year was 11.57 (SD = 10.26). The last decade (2011–2020) accounts for 79% (n = 192) of publications, and, overall, 2020 stands out (n = 40; 16.46%).

Given the fluctuating distribution of the data, a polynomial trend line was used to estimate the next 10 years. To reliably identify peaks, the sum of the mean and standard deviation (21.83) was considered. As only one peak was observed in the curve from 2016 onwards, order 2 was used, and the function shown in Figure 2 was obtained, revealing a growth trend. The coefficient of determination (R2) was approximately 0.9278, indicating strong reliability of the model generated to explain

7 Information on the items included is available at: https://doi.org/10.6084/m9.figshare.21656132.v1

the variability of the data and estimate the frequency of articles in the following ten years.

Figure 2
Distribution of articles by year and trend line for the following ten years



Source: the authors.

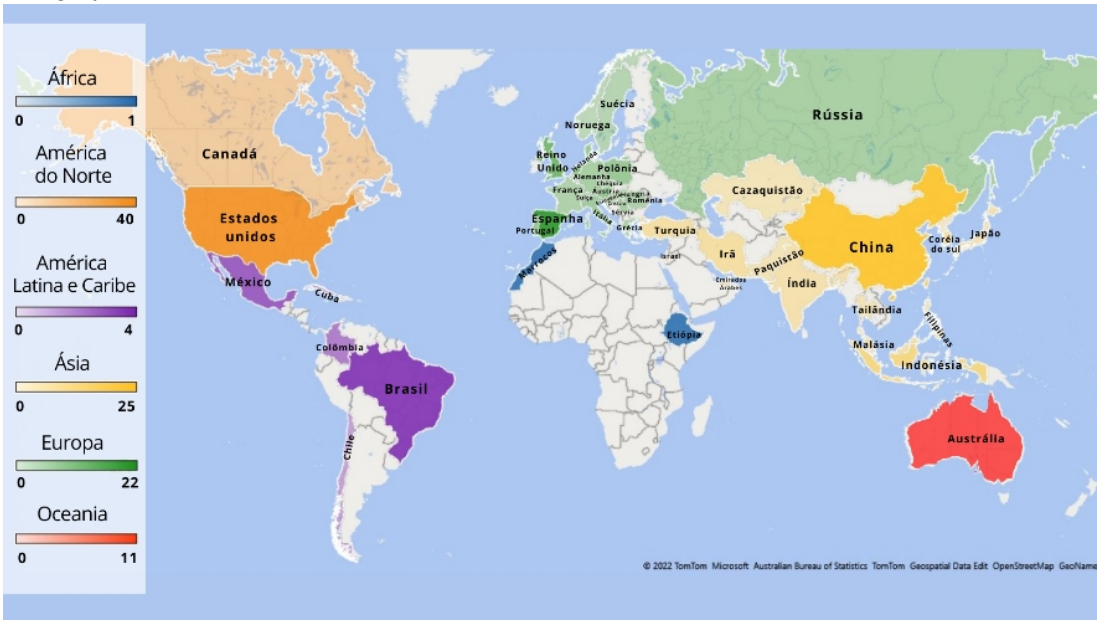
Regarding the geographic distribution of IAC, four articles (1.43%) reported interventions conducted in more than one country, and 14 (4.93%) did not provide sufficient information for this analysis.

A total of 280 IACs were counted, distributed across 50 territories[8]. The European continent stood out (f = 104; 36.62%), with emphasis on Southern Europe (f = 45; 16.07%), and the Asian continent, with emphasis on East Asia (f = 50; 17.85%).

When ranking IAC frequencies by territory, considering Taiwan as an independent country, the United States (f = 40; 14.08%) has the highest frequency, followed by China (f = 25; 8.80%). If Taiwan is included in Chinese territory, China (f = 43; 15.36%) surpasses the United States. In the same ranking, Brazil (f = 4; 1.41%) is tied with Russia, Germany, Greece, and Serbia, ranking 19th. Among the other territories, 15 had five or more IACs, 14 had between two and four IACs, and 18 territories (6.42%) recorded only one IAC.

8 The complete list is available at: https://doi.org/10.6084/m9.figshare.22775438.v2

Figure 3
Geographical distribution of interventions

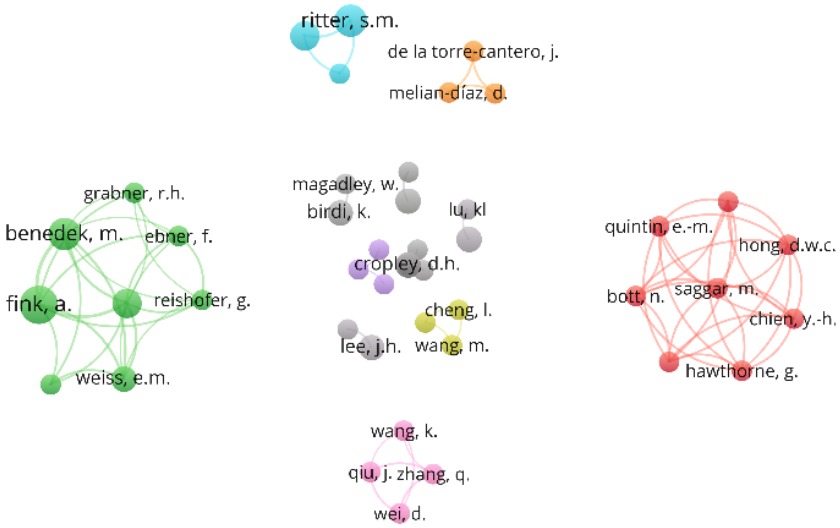


Note: the color gradation indicates the position of each territory in relation to its respective continent.
Source: the authors

In the analysis by researchers and scientific collaboration networks, 758 authors were identified, but only the 60 (7.91%) who had at least two publications were considered in the co-authorship analysis. As a result, a map with 30 clusters was generated (Figure 4): two with eight authors (cluster 1/red and cluster 2/green); one with four authors (cluster 3/pink); four with three authors (cluster 4/yellow, cluster 5/purple, cluster 6/blue, and cluster 7/orange); five with two authors (clusters 8-12); and 18 with only one author (clusters 13-30). No links were identified between authors from different clusters. Among the clusters, the following stood out in terms of average occurrences: cluster 2/green (Mo = 3.38; SD = 1.85), with an average strength of 12.25 (SD = 5.01) of connection between authors; and cluster 6/blue (Mo = 3.67; SD = 1.53), with an average strength of 14 (SD = 0.58) of connection between authors[9]. Considering all 758 authors, the average number of occurrences was 1.11 (SD = 0.45). Those with four or more publications were highlighted (Table 1).

9 The complete results can be accessed at: https://doi.org/10.6084/m9.figshare.22775438.v2

Figure 4
Scientific collaboration networks between authors



Note: the full map can be downloaded at https://doi.org/10.6084/m9.figshare.22775438.v2
Source: the authors

Table 1
Authors highlighted on the co-authorship map and bibliometric indicators

Author	Cluster	.	lg	flg	ma
A. Fink	2	7	7	20	2013.14
M. Benedek	2	5	7	16	2014.2
S. M. Ritter	6	5	2	5	2019.2
K. Koschutnig	2	4	7	17	2013.75
X. Gu	6	4	2	5	2020.75

Note: *o* = number of occurrences; *lg* = number of links; *flg* = total link strength; *ma* = average year of publication.
Source: the authors.

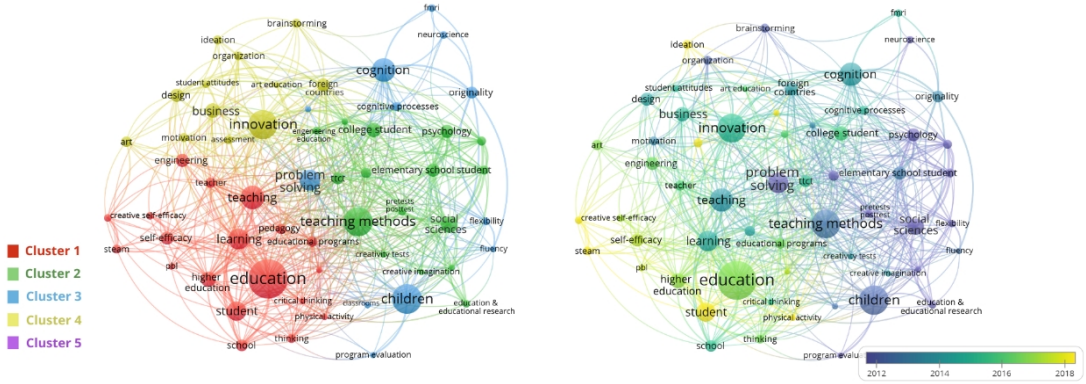
As for the research's thematic focus, according to the cutoff point suggested by VOSviewer, of the 1,085 keywords identified, only those that appeared at least 5 times (n = 75; 6.91%) were preprocessed and analyzed. A map was obtained with 59 terminologies organized into four clusters (Figure 5 and Figure 6). Cluster 1 contains 19 keywords, Cluster 2 contains 16, Cluster 3 contains 12, and Cluster 4 contains 12 keywords. The most representative keywords for each cluster are shown in Table 2[10].

When comparing the averages of the mean years of the keywords for each cluster, a significant difference [F(59; 3) = 14.558, p < 0.001] was observed between them. With Tukey's post hoc test, it was observed that cluster 1 (M = 2016.63; SD = 1.65) did not differ (p = 0.161) from cluster 4 (M = 2015.03; SD = 1.97), which, in turn, did not differ (p = 0.093) from cluster 3 (M = 2013.04; SD = 2.55). Cluster 2 (M =

10 The complete set of results with the translations of the keywords can be accessed at: https://doi.org/10.6084/m9.figshare.22775438.v2

2012.46; SD = 2.14) differs from cluster 4 ($p < 0.01$) and cluster 1 ($p < 0.001$), but not from cluster 3 ($p = 0.884$). Thus, cluster 1 tends to feature the most recent terminology, while cluster 2 tends to include the less recent terminology.

Figure 5
Co-occurrence networks of keywords from interventions to increase creativity (visualization by clusters)



Note: Visualization by clusters (left) and visualization by average year of occurrence (right). The full map can be downloaded at https://doi.org/10.6084/m9.figshare.22775438.v2
Source: the authors.

Table 2
Keywords highlighted in the co-occurrence map and bibliometric indicators

Keyword	Cluster	.	lg	flg	RI	ma
education	1	30	40	83	99600	2016.57
teaching	1	18	39	71	49842	2013.89
learning	1	16	31	52	25792	2014.44
higher education	1	15	28	42	17640	2018.20
teaching methods	2	22	37	79	64306	2012.86
social sciences	2	13	35	70	31850	2011.46
psychology	2	10	25	46	11500	2011.40
cognition	3	18	27	44	21384	2014.06
children	3	23	23	39	20631	2012.52
problem solving	3	16	19	27	8208	2011.56
innovation	4	22	34	59	44132	2015.05
foreign countries	4	10	30	42	12600	2014.00
business	4	11	21	30	6930	2014.91

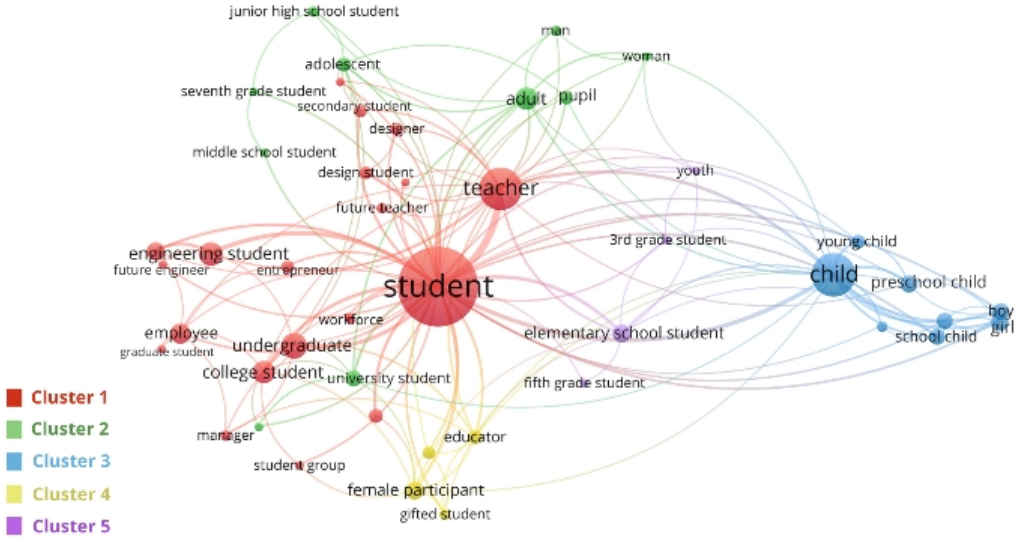
Note: *o* = number of occurrences; *lg* = number of links; *flg* = total link strength; RI = relevance index (*o* x *lg* x *flg*); *ma* = average year of publication.
Source: the authors.

The co-occurrence analysis of titles and abstracts detected 5,570 terms. Only those terms with an occurrence greater than or equal to the average occurrence of all terms (M = 2.04; SD = 5.82) were mapped, i.e., those that appeared in at least two publications (n = 1050; 18.85%). Among these, 47 (4.48%) were categorized as

populations and 71 (6.76%) as contexts[11]. For interpretation purposes, RI was also considered.

Regarding the population map (Figure 6), five clusters were identified. The first contains 21 terms, the second contains 10, the third contains 8, and the fourth and fifth each contain 4 terms. The most relevant terms for each cluster are presented in Table 3.

Figure 6
Networks of populations of interventions to increase creativity



Note: The full map can be downloaded at https://doi.org/10.6084/m9.figshare.22775438.v2
Source: the authors

Table 3
Terms for populations highlighted in the co-occurrence analysis of titles and abstracts

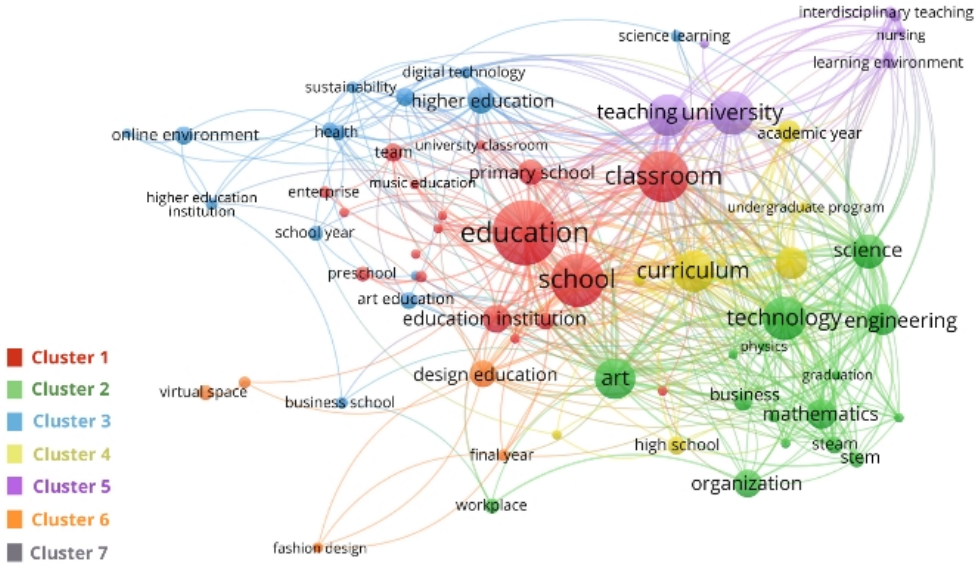
Term	Cluster	.	lg	flg	RI
Student	1	148	46	175	1191400
teacher	1	42	25	69	72450
undergraduate	1	15	8	17	2040
adult	2	12	10	18	2160
university student	2	6	7	13	546
adolescent	2	13	35	70	2011.46
child	3	44	18	57	45144
boy	3	7	6	18	756
girl	3	7	6	18	756
female participant	4	8	10	16	1280
educator	4	5	9	14	630
elementary school student	5	8	9	18	1296

11 The complete data and translation of the terms for populations and contexts are available at: https://doi.org/10.6084/m9.figshare.22775438.v1

Note: *o* = number of occurrences; *lg* = number of links; *flg* = total link strength; RI = relevance index (*o* x *lg* x *flg*).
Source: the authors.

As for the context map (Figure 7), seven clusters were identified, with their most relevant terms presented in Table 4. Cluster 1 consists of 18 terms, Cluster 2 of 16, and Cluster 3 of 14. Clusters 4 and 5 each include eight terms, while Cluster 7 contains only one term.

Figure 7
Networks of contexts of interventions to increase creativity



Note: The full map can be downloaded at https://doi.org/10.6084/m9.figshare.22775438.v2
Source: the authors

Table 4
Clusters 4 and 5 each include eight terms, while Cluster 7 contains only one term.

Term	Cluster	.	lg	flg	RI
education	1	50	43	144	309600
school	1	36	40	104	149760
classroom	1	33	37	105	128205
technology	2	25	37	125	115625
art	2	22	37	94	76516
science	2	17	34	105	60690
engineering	2	14	32	90	40320
higher education	3	11	20	32	7040
elementary school	3	6	17	21	2142
institution	3	4	14	17	952
curriculum	4	23	34	95	74290
engineering education	4	15	22	48	15840
university	5	26	34	90	79560

teaching	5	23	34	94	73508
design education	6	11	22	29	7018
product development	7	3	0	0	0

Note: *o* = number of occurrences; *lg* = number of links; *flg* = total link strength; RI = relevance index (*o* x *lg* x *flg*).
Source: the authors.

Discussion

The results show that scientific production on IAC has grown and is expected to increase further in the next decade. They are consistent with those of Hernández-Torrano and Ibrayeva (2020), who mapped research on creativity and education from 1975 to 2019, asserting that the field has grown exponentially since the 2000s.

From a strictly quantitative point of view and considering only the area of creativity, it can be observed, for example, that the annual average number of publications on IAC (11.57) does not differ significantly from that observed in the bibliometric analysis by Kupers et al. (2019) on children's creativity (M = 15.33; t(21; 20) = 1.679; p = 0.109) or that obtained by Snyder et al. (2019) on the measurement of creativity in undergraduate students (M = 14.87; t(21; 20) = 1.473; p = 0.156). Although both Kupers et al. (2019) and Snyder et al. (2019) have relatively broad focuses, the focus of this review is even broader. Therefore, it is possible to state, albeit cautiously, that despite growth, 21st-century scientific production on IAC is quantitatively below what is necessary to achieve, for example, goals related to the development of nations (United Nations, 2017), health (WHO, 2020), work (WEF, 2020), and education (Henriksen et al., 2018).

The geographic distribution of interventions is uneven, both between continents and between territories. Although 50 territories were identified, a large part (n = 18; 36%) had a punctual role, with only one publication. It should be clarified that some nations, such as Brazil, occupy a prominent position on their continents but not globally. Although Brazilian scientific production on creativity is internationally recognized, specific studies on IAC remain scarce in the country, as Nakano (2011) warned more than a decade ago.

Since creativity is understood as a fundamental skill for the 21st century and enhancing it is an international goal (e.g., Henriksen et al., 2018; United Nations, 2017), the union of local efforts is vital for achieving global objectives. It should be recognized, however, that a country's scientific output is subordinate to its economic and geopolitical position (Carter, 2008). Therefore, it is not surprising that interventions are concentrated in economic powers, especially in the United States, and that developing countries have low productivity. Traditionally, research in the psychology of creativity – as well as in other areas – has been conducted by and for Western, Educated, Industrialized, Rich and Democratic (WEIRD) populations (Glăveanu, 2019). It should also be noted that, for the most part, these groups are composed of white populations. The fact that China stands out in IAC production may seem contradictory to the WEIRD' criticism'. However, one must consider its

economic emergence and, related to this, the high investment in science and technology.

A more balanced and culturally diverse landscape regarding IAC territories needs to be fostered through transnational collaborations. Only four articles (1.43%) report interventions in more than one country. However, it is not enough to simply 'bring together' authors from different countries. These collaborations should value sociocultural specificities in the planning, implementation, and evaluation of IACs (Glăveanu, 2019).

Overall, productivity on creativity-enhancing interventions is driven by several researchers, but a large proportion (n = 698; 92.08%) contributed only one publication. In addition, contributions from those who publish more than once seem to occur in a disjointed manner, without collaboration between different research groups and, therefore, without a research network. This was not observed in Hernández-Torrano and Ibrayeva's (2020) mapping of creativity and education, as the authors collaborated across different clusters.

Regarding the field of IACs, fragmentation is detrimental to their scientific and technological advancement, given that contemporary science calls for broad networks of collaboration between authors and institutions (Li et al., 2021). It should be noted that authors identified in other mappings (Long et al., 2014; Williams et al., 2016) as 'references' in creativity science did not appear with the same prominence in this review, indicating that basic research, applied research, and technologies may be being developed by different researchers. Among the few groups that stand out is one composed of researchers in the neuroscience of creativity, led by A. Fink of the University of Graz, Austria (e.g., Fink et al., 2018). There is also a group focusing on cognitive science, represented by S. M. Ritter, from Radboud University, Netherlands (e.g., Ritter et al., 2020).

Research approaches to IAC encompass all four aspects of creativity proposed in Rhodes' conceptualization (1961): person (e.g., motivation, creative self-efficacy), process (e.g., problem-solving), product (e.g., art), and environment (e.g., classrooms). They also mention aspects of everyday life, in line with the trend emphasized by Villanova and Cunha (2021).

The clusters formed reveal that the main themes are those related to education (Cluster 1), teaching methods (Cluster 2), cognition (Cluster 3), and innovation (Cluster 4). The first two tend to encompass areas of research that include the connection between IACs and more general educational processes or more specific teaching strategies. Although educational processes are levers for creativity in both clusters, it should be noted that creative thinking has a bidirectional connection with education. As highlighted by Henriksen et al. (2018), it can serve both as an educational goal and as a means to optimize learning. Additionally, increased creativity and its connection to teaching methods seem to be studied mainly by the social sciences, especially psychology and pedagogy. Paradoxically, these two clusters (Clusters 1 and 2) tend to cover more and less current topics, respectively.

The theme of cognition (Cluster 3) primarily covers constructs related to psychological processes that IACs aim to promote to achieve their overall goal: to foster potential and creative performance. Components of divergent thinking (e.g., flexibility) and problem solving stand out. Furthermore, it should be noted that these interventions primarily focus on children from a cognitive science and neuroscience perspective.

The focus on innovation (Cluster 4) seems to be mainly related to the context of businesses and organizations, as also evidenced by Williams et al. (2016). Innovation is generally conceived as a construct in its own right, which includes creativity (Nakano & Wechsler, 2018). In this sense, it requires creative performance associated with generating ideas, followed by the implementation of these ideas and the production of economic impact, which is increasingly valued in the job market.

Regarding the populations involved in the interventions, students seem to predominate, but a strong connection with teachers can be observed. This highlights the key role of teachers as promoters of student creativity. As noted in the reviews by Alves-Oliveira et al. (2022) and Ruiz-del-Pino et al. (2022), teacher training is a frequent strategy in IACs in the educational context, given the multiplier function of these professionals and their influence on student creativity. Among the students, there are different educational levels, ranging from preschoolers to undergraduates, with emphasis on the latter.

When it comes to the stages of life, children stand out. IACs can take advantage of the great malleability of creative potential in childhood to develop skills and behaviors that precede creative performances in adulthood (e.g., symbolic play) (Hui et al., 2019). However, given the role of creative competence in human development, the set of interventions to increase it can and should cover the entire age spectrum (Barbot et al., 2016), adopting a *life-span* perspective, that is, the life cycle. It also needs to consider the specificities of each life-course moment, as well as the dynamic and non-linear character of creative development (Hui et al., 2019). Adults and adolescents appear in the results referring to populations, but with fewer occurrences, and both in the same cluster, strongly linked to the academic context. No references to older persons, as IAC populations were identified. As Nakano et al. (2021) point out, although teaching creative skills promotes healthy aging, research and interventions focused on older adults remain rare.

As for the contexts of IACs, educational settings predominate, with schools and universities particularly noteworthy. Although educational spaces are, by nature, conducive to skill development (WHO, 2020), a series of studies has identified flaws in this pedagogical exercise, as well as various barriers within these institutions to student creativity (Alencar & Fleith, 2009). The emphasis on interventions in the educational context observed in this study, involving different levels of education and including curriculum proposals, suggests a possible recent transformation of this scenario. References to the organizational context also appeared, but less frequently and without characterizing a distinct cluster. This suggests that interventions to increase creativity in organizational spaces are, in some way, linked

to the educational context. This was not observed by Williams et al. (2016) in their mapping of general science approaches to creativity, as the educational and organizational contexts formed separate clusters.

This focus on the academic context is criticized by Van der Zanden et al. (2020), who warn of the scant attention given to extracurricular social environments, which is in line with the results found here. No IACs were identified in unconventional settings, such as family, community, and prison. As creative potential develops in a sociocultural context, it is influenced by all the spaces that the individual occupies (Barbot et al., 2016) and, consequently, can be fostered and manifested in almost all of them. Thus, effective interventions to increase creativity should maximize opportunities and minimize barriers in the main contexts of individual development (Alencar & Fleith, 2009), including the family and community.

Conclusion

Given that diversity was a priori considered a distinctive feature of research on IAC, this scoping review mapped the scientific literature, prioritizing sensitivity over specificity. Scientometric analyses enabled the description of the state of the art in IAC, identification of trends, and highlighting knowledge gaps. In summary, research on IAC has increased in the 21st century, but not yet sufficiently to achieve global objectives, due to limitations in research networks, territories, populations, and contexts covered.

The results should be interpreted with caution, considering the limitations of this study. As there was no analysis of the types of activities carried out and their outcomes, nor any evaluation of the research methodology and bias controls, it is not possible to make statements about the quality and effectiveness of the interventions. Furthermore, word network analyses are subject to biases related to how authors use terminology, despite efforts to minimize them. For example, it was identified that children stand out as a population, but specific age groups were not analyzed.

Despite these and other limitations, the results of this review have undeniable academic, professional, and social contributions, as the characterization of scientific production in IAC presented here can inspire future research and practices toward achieving local and global objectives. This study is also somewhat original, as the scientometrics analysis covered a wider range of 21st-century research on IAC than has commonly been the subject of similar investigations. Thus, *'soft science'* was also contemplated.

Another contribution of this review is its clear highlighting of the need for further research on IAC. However, simply producing more studies is not enough. It is imperative to build a research agenda on IAC that is characterized by greater collaboration among researchers through transnational (especially South-South and North-South) and cross-cultural partnerships. Studies covering a greater diversity of territories, populations, and contexts should also be scheduled, including, for example, interventions with older adults and in the community context.

In the professional sphere, the results indicate the existence of recent technologies to increase creativity, especially among students, suggesting the transfer of these IACs to school and organizational contexts. The continuation of the investigations initiated in this study is crucial for furthering the analyses and supporting professional practices.

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Resumo

Para analisar a produção científica sobre intervenções para aumentar criatividade, realizou-se uma revisão de escopo baseada nas diretrizes PRISMA-ScR. Foram recuperados artigos de pesquisas empíricas publicados entre 2000 e 2022 em inglês, português ou espanhol. Os 274 textos incluídos foram submetidos a análises cientométricas baseadas em autoria, ano de publicação, título, resumo, palavras-chave e na seção método. Verificou-se uma tendência de crescimento das publicações com o tempo e uma distribuição geográfica das intervenções em 50 territórios, com destaque para Estados Unidos e China. Foram identificados 758 autores, dos quais apenas cinco tinham quatro ou mais artigos. As temáticas das pesquisas se relacionaram, principalmente, à educação, aos métodos de ensino, à cognição e à inovação. Como população-alvo e contexto das intervenções, sobressaíram-se professores e estudantes em espaços educacionais. Os resultados sugerem restrições das redes de colaboração entre autores, dos territórios, populações e contextos abrangidos pelas intervenções.

Palavras-chave: Criatividade. Tecnologia. Cientometria. Intervenções.

Resumen

Para analizar la producción científica sobre intervenciones para aumentar la creatividad, se realizó una revisión de alcance basada en las directrices PRISMA-ScR. Se recuperaron artículos de investigaciones empíricas publicados entre 2000

y 2022 en inglés, portugués o español. Los 274 textos incluidos se sometieron a análisis cienciométricos basados en la autoría, el año de publicación, el título, el resumen, las palabras clave y la sección de método. Se observó una tendencia al alza en las publicaciones a lo largo del tiempo y una distribución geográfica de las intervenciones en 50 territorios, con especial destaque para Estados Unidos y China. Se identificaron 758 autores, de los cuales solo cinco tenían cuatro o más artículos. Los temas de las investigaciones se relacionaron principalmente con la educación, los métodos de enseñanza, la cognición y la innovación. Como población objetivo y contexto de las intervenciones, destacaron los profesores y los estudiantes en espacios educativos. Los resultados sugieren restricciones en las redes de colaboración entre autores, territorios, poblaciones y contextos cubiertos por las intervenciones.

Palabras clave: Creatividad. Tecnología. Cientometría. Intervenciones.

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