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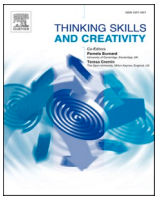

The impact of risk-taking and creativity stimuli in education towards innovation: A systematic review and research agenda

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ABSTRACT

Academic research on educational stimuli of risk-taking and creativity to foster innovation can contribute to overcome the challenges faced by organizations in the marketplace. To explore the contributions provided in this field, this study developed a bibliometric and systematic review on academic production in the domain of creativity, risk-taking and innovation through an educational perspective. The bibliographical databases adopted were Web of Science and Scopus and outcomes were analysed using the Bibliometrix tool in R software. Research findings point to three main clusters of academic production: (i) Tools and techniques to boost creativity; (ii) Educational interventions towards innovativeness; and (iii) Antecedents of entrepreneurial activity. This study pictures entrepreneurial education as a field that is still in its infancy and, thus, provide opportunities for research and education policies and programs design. It was revealed that there are two relevant fields that can be envisaged as motor themes for policies and programs design: (i) "social innovation, design education, and design thinking" and (ii) "education, design, and design process". Both fields point to the dominance of multidisciplinary approaches and design as a central vehicle to creativity, risk-taking, and innovation diffusion.

1. Introduction

Innovation seldom occurs in isolation, as it is immersed in a social context (Poutanen & Kovalaine, 2017). To tackle the constant need for innovation, firms are dependent on their creative structure and the general economic and institutional scenarios present in their environments. In addition, innovation is hardly a task achievable only by individual efforts (Fetrati et al., 2022; Leonard & Sensiper, 1998), posing great responsibility in entrepreneurs, teams and employees. In this paper, we examine the intersection of risk-taking and creativity approaches in education towards innovation.

To change or to do something new is an innate characteristic of innovation, as changes lead to a cycle of firms being born at the same time others are dying. From a Schumpeterian perspective (Schumpeter, 1934), this succession of events is the impulse to economic development and technological progress (Obschonka & Fisch, 2018). Innovation has also been described as a creative achievement (Parjanen & Hyypiä, 2019) accomplished through collaboration among cognitively diverse agents who develop mechanisms to turn risk-taking into a powerful resource in the creation of shareholder value (Low, 2009). How are the changes triggered or

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promoted? How can education stimulate the process of innovation? What is the role of creativity and risk-taking in this process?

As a personality attribute, creativity is "a cognitive and social process"(Amabile & Pillemer, 2012, p.3), thus being supported or suppressed by general social conditions. Furthermore, this feature is often associated with curiosity (Ogbeibu et al., 2021; Schutte & Malouff, 2020), knowledge (Auernhammer & Hall, 2014; Leonard & Sensiper, 1998), and collaboration (Puccio et al., 2020), which endorses the effectiveness of teamwork on the development of new ideas. According to Leonard and Sensiper (1998, p. 115), creativity derives from a combination of "conscious, semiconscious, and unconscious mental sorting, grouping, matching, and melding". This process is empowered by multiple interactions among individuals whose subjectivities combine to enrich decision-making. For Castillo-Vergara et al. (2018), individual creativity is the root of organizational creativity and, hence, of innovation. Organizational creativity, in turn, acknowledges the importance of individual creativity (be they in a team or the leaders) and its intersections with collective creation, culture integration and sociological approach to sensemaking in the creative process overtime (Fetrati et al., 2022).

However, even though creativity is intimately linked to the innovative process, the first does not automatically generate the latter. The two variables only positively influence each other by the intermediation of risk-taking (Hadjielias et al., 2021). Risk-taking is employed in any situation that involves a specific gain versus another alternative of which the outcome is uncertain Tversky and Kahneman (1974). Openness to risk in a creative environment has been identified as a central feature for teams involved in innovation (Hadjielias et al., 2021), a tendency that might be explained by the role of failed initiatives in triggering innovation in the long term (Ferreira et al., 2020). In addition, risk assessment leads individuals to frame riskier choices as opportunities rather than obstacles (Röth & Spieth, 2019). Thus, risk-taking can be theorized as a bridge that turns creativity into potential innovation. But can the triad risk-taking, creativity, and education towards innovation be stimulated through educational activities? From what ages, in which settings?

A core line of research in creativity from authors such as Amabile (1988, 1996a, 1996b, 2012) and Sternberg (1985, 2003, 2007) has been creating knowledge on the subject and serving as support to multidisciplinary approaches, such as those in engineering (Toh & Miller, 2016), in education (Craft et al., 2013) or in entrepreneurial education (Smith & Beasley, 2011; Ncanywa, 2019; Pinto et al., 2019). There has been support to include creativity and sometimes creativity and innovation in different levels of education and courses (e.g.: Cheng, 2011; Cropley, 2015; Whitton, 2018) with the argument that the earlier it is introduced, the better.

As discussed above, there are some fragmented initiatives on research and on the education systems in areas dealing with the triad creativity-risk-taking-innovation. This way, a consolidated panorama is still needed to provide insights for future research and education policies, as well as program design on entrepreneurial education. Therefore, some questions will drive this study: What efforts are being made in Entrepreneurship education? How is higher education in Business coping with the elements of risk-taking, creativity and innovation in the classroom? What are the agenda and the profile of academic research on education on risk-taking, creativity and innovation?

In order to answer the aforementioned questions, we employed a systematic review based on the following methodological sequence: (1) Data Collection, (2) Bibliometry, and (3) Content Analysis (Denyer & Tranfield, 2009). Search included documents that approached creativity, risk-taking and innovation in the context of education. After further screening, and eligibility checks, 86 articles were included in the bibliometric analysis. Meanwhile, the content analysis was performed with 79 articles that were grouped into three clusters: (1) tools and techniques to boost creativity; (2) educational interventions towards innovativeness, and (3) antecedents of students' entrepreneurial activity. Methods and findings are described in the next sections (Table 1).

2. Methods

This study employed a methodological sequence based on the steps suggested by Denyer and Tranfield (2009): (1) Data Collection, (2) Bibliometry, and (3) Content Analysis.

2.1. Data collection

The first step for this study analysis was to choose the most prolific combination of search strings. Also, the data collection was

Table 1
Top journals ranked by number of articles in the selection.

Source	Number of articles in the collection	Impact Factor*	Citation Indicator*
Thinking Skills and Creativity	6	3.652	1.93
Art, Design & Communication in Higher Education**	3	–	1.71
Psychology of Aesthetics, Creativity, and the Arts	3	6.395	8.09
Creativity and Innovation Management	2	3.644	0.84
Education and Training	2	3.058	1.46
Frontiers in Psychology	2	4.232	1.04
International Journal of Engineering Education	2	0.971	0.40
International Journal of Engineering Pedagogy (IJEP)**	2	–	0.87
International Journal of Innovation, Creativity and Change	2	0.304***	0.20***
Journal of Entrepreneurship Education	36	–	–
	2		

Note: *According to Clarivate's Journal Citation Report (JCR) - ** Recently added to JCR. - ***According to Academic Accelerator.

performed in June 2022, considering the string ((“risk-taking” AND innovate* AND creativ*) OR (“risk taking” AND innovat* AND creativ*) OR (risk AND innov* AND creativ*)) applied to title, abstract, and keywords. Therefore, these combinations were adopted in this research both on the Scopus and Web of Science (WoS) Core Collection databases. These sources were employed due to a variety of filters that allow for easy indexation by journals, also being recognized as top-notch and reputable platforms (Falagas et al., 2008; Mongeon & Paul-Hus, 2016; Singh et al., 2021).

Another justification refers to the compatibility of both Scopus and Web of Science with Bibliometrix, which considerably automatizes analyses (Aria & Cuccurullo, 2017). As aforementioned, our search included the fields title, abstract, and keywords and no specific period of start was delimited as there was no theoretical foundation so far to pre-establish an initial year of publication. These steps resulted in 1049 documents in the Scopus database and 319 documents in the Web of Science Core Collection. For this selection, the PRIMA protocol was followed(Moher et al., 2015) as shown in Fig. 1.

First, all documents in the first step (screening) were confirmed to be articles considered empirical. A study is considered empirical

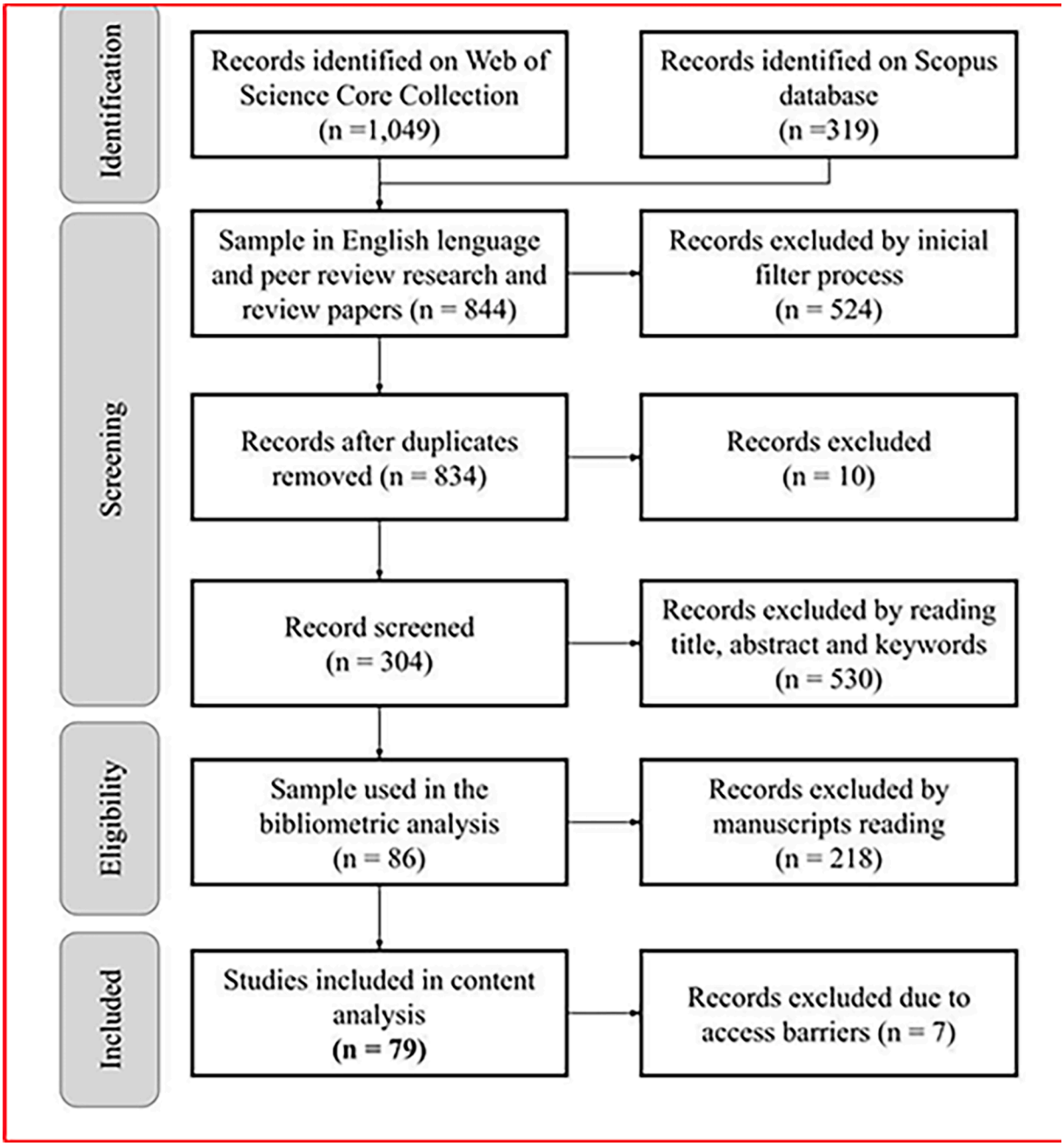

Fig. 1. PRISMA Protocol by the sample studied.

when it seeks to evaluate the functioning of a specific phenomenon in an applied manner (Powell & Butterfield, 1994). Thus, this study opted to exclude reviews, meta-analysis, conference papers, book chapters, books, and editorials, which is usual in creativity management studies (Davies et al., 2013; Lill et al., 2020; Moirano et al., 2020). After this exclusion process, 844 documents remained. These were taken to Mendeley® Software for reference management.

While reviewing articles' information on Mendeley, 10 more documents were found to be duplicates, leading to a number of 834 unique records. Next, all records were submitted to a careful evaluation of title, abstract, and keywords to evaluate if their content was in fact related to the objective of our study. By reading each document fully, we then confirmed (or not) our initial impression on their contributions. This filtering process led to the discarding of 530 records, then leading to 304 records to be checked concerning relevance to the research question. This step generated the discard of 218 records, leaving 86 documents to be submitted to bibliometric analysis and to be read in full for content analysis. However, in the reading phase, seven documents were excluded for being neither accessible online nor through direct contact with authors (i.e. no reply was provided in time for inclusion). Therefore, 79 articles were included in the content analysis performed in this study (see Fig. 1).

2.2. Bibliometric analysis method

Bibliometric analysis is a valuable tool to identify research trends over time, the changes and ramifications of a research field, and detect the most productive authors, institutions, and countries to establish a state of art in a particular topic (Aria & Cuccurullo, 2017). In addition, "bibliometrics offers a powerful set of methods and measures for studying the structure and process of scholarly communication" (Borgman & Furner, 2002, 2). This map of communications can measure the structure of a social network formed by scholars of a particular field around a specific topic in different periods (slices) of time (Aria & Cuccurullo, 2017). The Bibliometrix Package created in R language allows automating many bibliometric analyses and even creating new functions due to its accessible open-source platform biblioshiny (Aria & Cuccurullo, 2017).

2.3. Content analysis

Finally, content analysis was adopted in order to categorize all articles of the final sample according to the points we considered pertinent (Spens & Kovács, 2006). Content analysis followed the steps suggested by Elo and Kyngäs (2008): open coding, categorization and abstraction. Through these steps we sought to identify relevant information through a deductive process during coding in the communities studied. This information was analysed in two ways: a bibliometric analysis and a content analysis of empirical studies for each community. Finally, the abstraction stage supported the discussions among the authors present in the sample for each community.

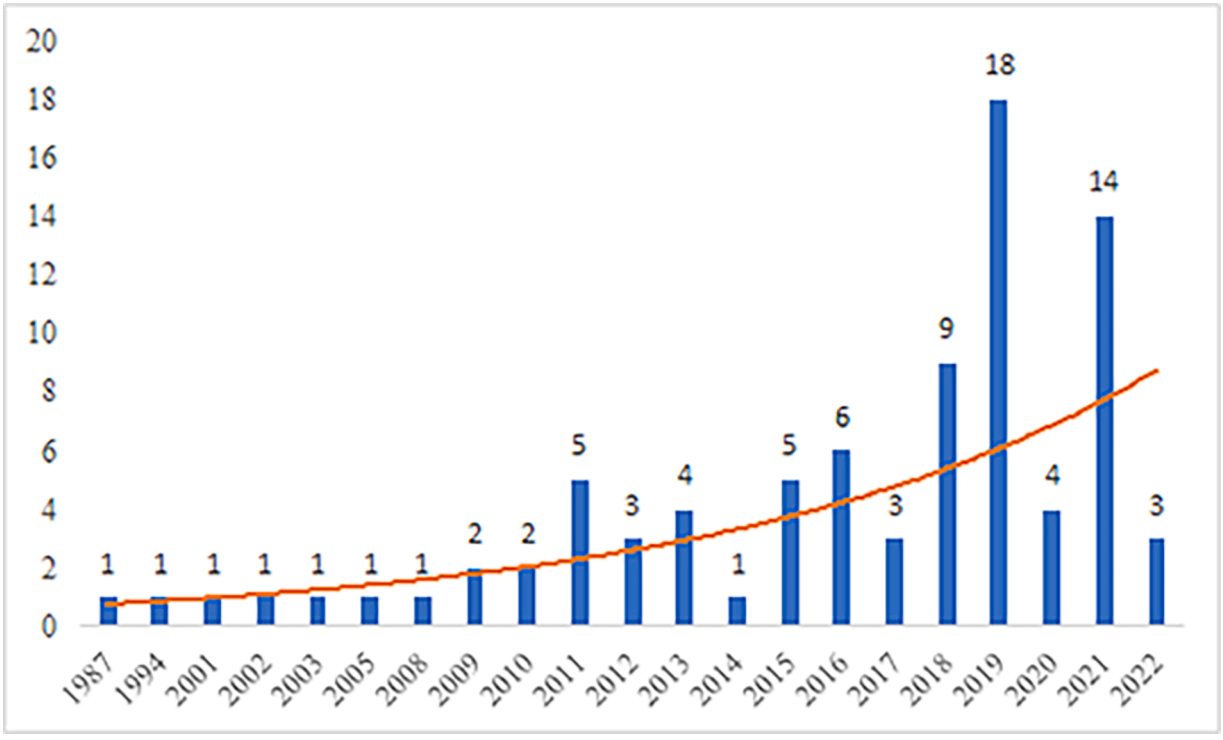

Fig. 2. Yearly publications and exponential tendency.

The aforementioned categorization was built according to the division of the information contained in the articles in different modalities so that the content analysis could be shaped in an organized manner. This way, the main criteria observed were: (i) presence of the three variables of interest (creativity, risk-taking, and innovation), (ii) presence of an educational perspective, and (iii) practical applications or significant theoretical contributions. Therefore, following the established restrictions, the detailed reading of the articles in the final sample was initiated, with views to identifying the information that comprises the delimited needs.

3. Results

3.1. Bibliometric analysis and findings

3.1.1. Yearly publication and time trend

Articles collected for bibliometric analysis ($n = 86$) ranged from 1987 to 2022. These documents were distributed in 68 sources, indicating a fragmentation of publications among many diverse outlets. The average citation per document was 10.07, with yearly citations of 1.36 per document (average). This collection counted on contributions by 205 authors, with an average index of 2.48 authors per document. The annual scientific production shows a spike in publication starting in 2009. After a period of irregular marks, the number of publications grew once again in 2015, but the most prolific time span was between 2016 and 2019, in which 36 articles on the theme were published. After a quick fall in 2020, with five publications, 2021 registered 14 articles published. So far, three documents have been published in 2022 as described in Fig. 2 (results obtained in July 2022). As indicated by the trajectory on the graph, the research on creativity, risk-taking and innovation in the realm of educational efforts is a theme that gathered growing interest throughout the years.

3.1.2. Top journals

The journals that most significantly contributed to the collection of articles are described in terms of their reputational indicators extracted from Clarivate's Journal Citation Reports (JCR) and the online tool Academic Accelerator. It can be noticed that both new outlets and traditional sources are involved in the theme. The journal with most contributions was Thinking Skills and Creativity (6 articles), followed by a newcomer Art, Design & Communication in Higher Education (published electronically in 2020), and another important player in creativity related studies: Creativity and Innovation Management (3 articles). Frontiers of Psychology, International Journal of Innovation, Creativity and Change and other three educational sources (Education and Training, International Journal of Engineering Education, International Journal of Engineering Education, and Journal of Entrepreneurship Education) complete the ranking. As indexes for Journal of Entrepreneurship Education are controversial (not found elsewhere but the outlet's own web page), we opted to not provide data on this specific source of publication.

3.1.3. Most impactful authors

The top 10 most relevant authors in publications on the triad risk-taking, creativity, and education towards innovation between 1987 and 2022 are exhibited in Table 2. Scores were based on their h-index (generated by bibliometrix and revised through Scopus). The top 5 most relevant authors in the list are Theodore Levitt (h-index = 38), David Cropley (h-index = 44), Scarlett Miller (h-index = 24), Anna Craft (h-index = 23), Pamela Burnard (h-index = 19) and Teresa Cremin (h-index = 18). Based on the number of articles present in the collection, only Christine Toh (h-index = 17) had more than one paper included. The top 10 authors' full details on h-index, Total Citations, and their initial year in publication are also designated.

3.1.4. Most impactful articles in the collection

Articles in the collection were ranked by impact and the metric adopted was Total Citations (TC). Interestingly, the first two articles in the list present opposing views on the role of creativity in real-life business. The 2002 article by Dr. Theodore Levitt "Creativity is not enough" argues against the idealized view of creativity in business routine, explaining that most of the academic projections are incompatible with the reality of the majority of companies. Meanwhile, the first most cited article (Cropley, 2015) advocates for the inclusion of creativity and innovation as core values in Engineering education, showing a much different perspective than that of

Table 2
Most impactful articles in the collection.

Author	h-index	TC	Initial year in research
LEVITT T	38	34,708	1983
CROPLEY D	34	5296	2003
MILLER S	24	2113	2009
CRAFT A	23	2141	1991
BURNARD P	19	1635	1995
CREMIN T	18	1150	2006
TOH C	17	831	2013
CHAPPELL K	12	449	2007
CHENG V	7	194	2004
DRAGOVIC T	7	344	2012

Note: TC = Total Citations.

Levitt's 2002 publication. The remaining articles exhibit a growing tendency of discussing creativity in the classrooms in various levels of education. The fact that most of these studies were published around a decade after Levitt's work shows a clear change of tides in the view of scholars towards creativity and its protagonism in future market prospects. The body of literature presented in Table 3 seems to indicate individuals should have contact with creativity much earlier than adult life and have this skill highly improved before they enter the workforce. We present journals' evaluation in order to establish the credibility of the sources in which the documents were published.

3.1.5. Author's co-citation network

As presented in Fig. 3, five co-citation networks were formed in the collection. The red network presents Dr. Teresa Amabile and Dr. Robert Sternberg as elementary sources on creativity. The blue network (at the bottom) is a microcosmos of these same references, but adopted in a different perspective by Dr. Christine Toh (design/engineering teams) and Dr. Ronald Beghetto (creativity as a catalyst for social change). In the green network, the most prominent researchers are Dr. Howard Gardner (cognition and education) and Dr. Anna Craft (creativity and education).

This network also includes James Kaufman, another important reference in the field of creativity. Finally, the purple network represents authors that employed creativity in business strategy, innovation, entrepreneurship, and learning processes in the educational system.

3.1.6. Thematic map

The thematic map diagram is useful to represent the density and centrality of authors' keywords (or other metrics of comparison) to visualize the overall structure of a specific domain (Lee & Jeong, 2008). The density indicates how keywords are related and the strength of the linkage they share in a specific cluster. Meanwhile, the centrality establishes the level of connection among keywords from different clusters (Giannakos et al., 2020).

In Fig. 4, seven thematic areas can be identified. They are arranged between Basic Themes (traditional streams of research) and Motor Themes (well-developed and important for the research field). Presented as basic themes are "creativity, innovation, and entrepreneurship"; "economic development and higher education"; "entrepreneurship and education"; "possibility thinking and drama". The thematic area of "entrepreneurial intention" seems to belong to both quadrants due to its basic nature but prolific potential for more applications and further investigation. As Motor Themes, there are two relevant fields: "social innovation, design education, and design thinking" and "education, design, and design process". Both research areas point to the dominance of design as a central vehicle to creativity diffusion.

3.1.7. Country scientific production

In order to explore the most productive countries through the country affiliation of authors and the country collaboration networks, we sorted countries by number of articles published to indicate productivity and established networks through affiliations among countries in the conduction of studies.

According to the country collaboration network (Table 4), the country with the most interactions was the United States, sharing research with Australia, the UK, Canada, Singapore, and India. Furthermore, the US was the country that achieved more collaborations in the selected articles (6). Spain had four collaborations (Romania, Chile, Peru and Colombia), as well as Chile (Spain, Colombia, and France), and Colombia (Spain, Chile, Sweden, and France). The remaining countries exhibited two connections (Austria, India, France, Kazakhstan, and Australia) or only one (Nigeria, Pakistan, Malaysia, Singapore, Germany, and Peru).

The USA alone published 50% of the total production, with the UK coming in second with 17.4%, Australia in third with 10.5%, and

Table 3
Most impactful articles.

Author/year	Title	TC	Source	Source IF
Cropley (2015)	Promoting creativity and innovation in engineering education	109	Psychology of Aesthetics, Creativity, and the Arts	6.395
Levitt (2002)	Creativity is not enough	97	Harvard Business Review	12.129
Cheng (2011)	Infusing creativity into Eastern classrooms: Evaluations from student perspectives	58	Thinking Skills and Creativity	3.652
Craft et al. (2013)	Possibility thinking: culminative studies of an evidence-based concept driving creativity?	45	Education 3–13	0.55 (JCI)
Mustar (2009)	Technology management education: Innovation and entrepreneurship at MINES Paris tech, a leading French engineering school	50	Academy of Management Learning and Education	6.149
Whitton (2018)	Playful learning: Tools, techniques, and tactics	44	Research in Learning Technology	1.10 (JCI)
riol et al. (2016)	Emotional creativity as predictor of intrinsic motivation and academic engagement in university students: The mediating role of positive emotions	43	Frontiers in Psychology	4.232
Beasley (2011)	Graduate entrepreneurs: Intentions, barriers and solutions	40	Education and Training	3.058
Toh and Miller (2016)	Choosing creativity: the role of individual risk and ambiguity aversion on creative concept selection in engineering design	47	Research in Engineering Design	2.964
MacLaren (2012)	The contradictions of policy and practice: Creativity in higher education	31	London Review of Education	0.66 (JCI)

Note: In the absence of the impact factor, Journal Citation Index (JCI) was adopted.

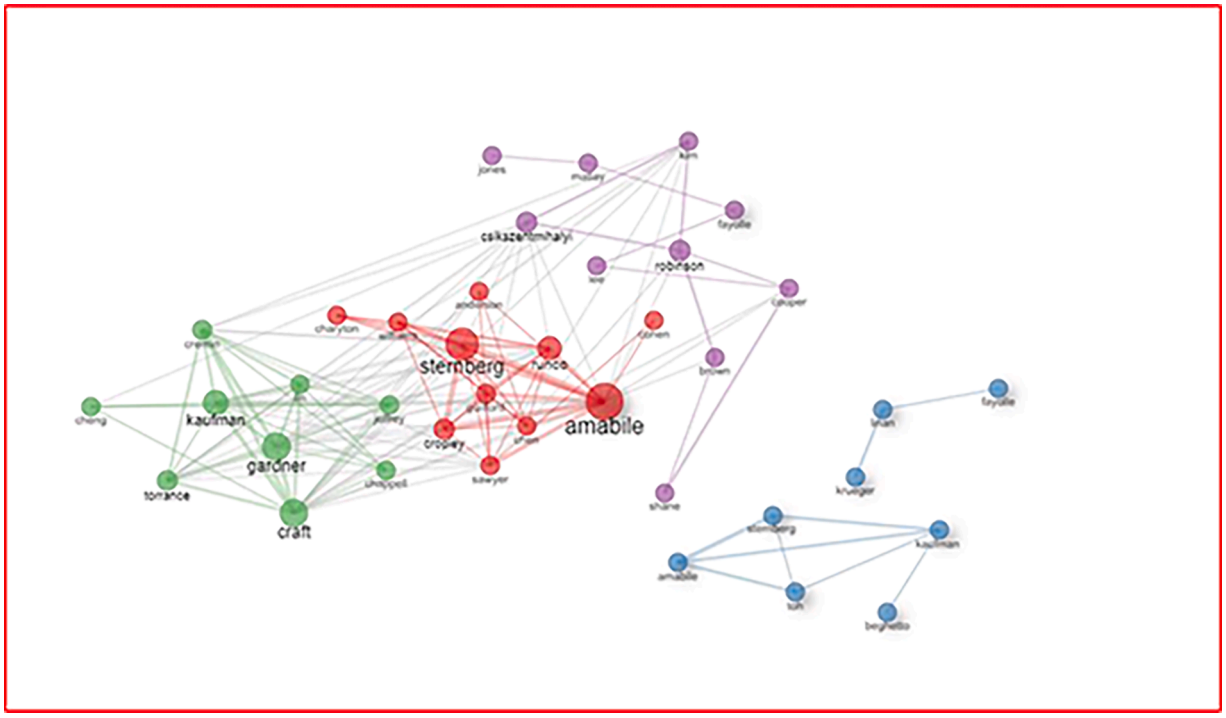

Fig. 3. Co-citation network of authors (50 nodes; Kamada and Kawai layout; clustered by Louvain algorithm).

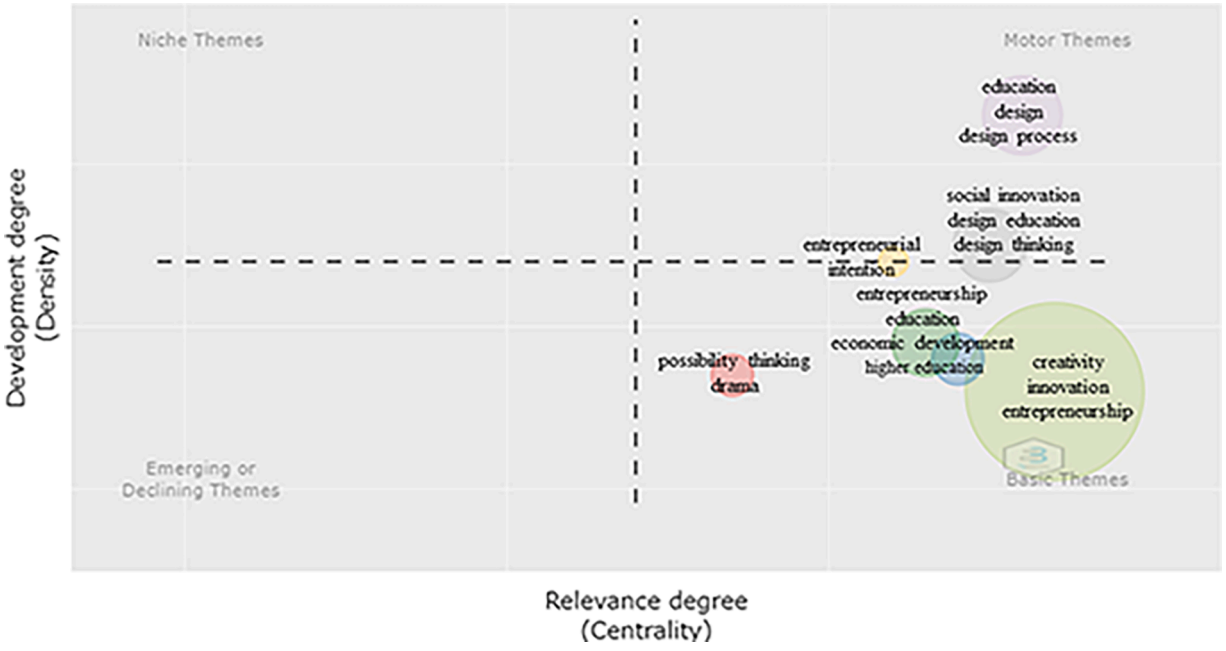

Fig. 4. Thematic map
Note: This map was based on the 110 more frequent authors' keywords and minimum of 5 occurrences per thousand in the cluster.

Table 4
Country scientific product and collaboration
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Country	N. of documents	Studies in collaboration	Collaborated with:
USA	43	6	United Kingdom, Australia, Canada, India, Kazakhstan, and Singapore,
UK	15	2	Kazakhstan, Nigeria, United States
Australia	9	2	United States, India
Canada	7	1	United States, United Arab Emirates (UAE)
China	6	–	–
Colombia	6	4	Chile, France, Spain, Sweden
Germany	6	1	Austria
Indonesia	6	–	–
Spain	6	4	Chile, Peru, Romania, Sweden, Colombia
Austria	5	2	Germany, Romania

Canada in fourth with 8.1%. China, which usually has a dense scientific publication, had only 7% of the articles in the collection. 11% from the USA and 10% from Spain.

4. Systematic literature review

In this section, the first step was content analysis. This phase aimed to gain a wider knowledge and understanding of the research field (Downe-Wamboldt, 1992). Next, findings are exhibited as research clusters and an agenda for future studies is proposed.

4.1. Content analysis

We submitted the 86 articles selected by title, abstract and keywords reading to the bibliometrix tool biblioshiny, which allowed the creation of three consistent thematic clusters. The clustering technique adopted used documents as units of analysis, coupling them by their abstracts mediated by local citation scores (number of citations inside the collection). The three clusters generated were: (1) tools and techniques to boost creativity; (2) educational interventions towards innovativeness, and (3) antecedents of students' entrepreneurial activity. The networks in Fig. 5 represent the articles in each cluster by proximity.

The evolution of publications in the three clusters is represented in Fig. 6. We chose the period comprehended between 2003 and 2007 as a start because this interval comprised the first time at least two clusters appeared simultaneously. Research prior to this time span was very much fragmented. All clusters presented a consistent growth throughout the years, with "Antecedents of entrepreneurial activity" appearing for the first time in the quadrennium 2008–2012. Since then, this was the cluster that evolved faster and now presents the highest number of publications, with the three clusters registering significant leaps in publication numbers compared to the previous interval.

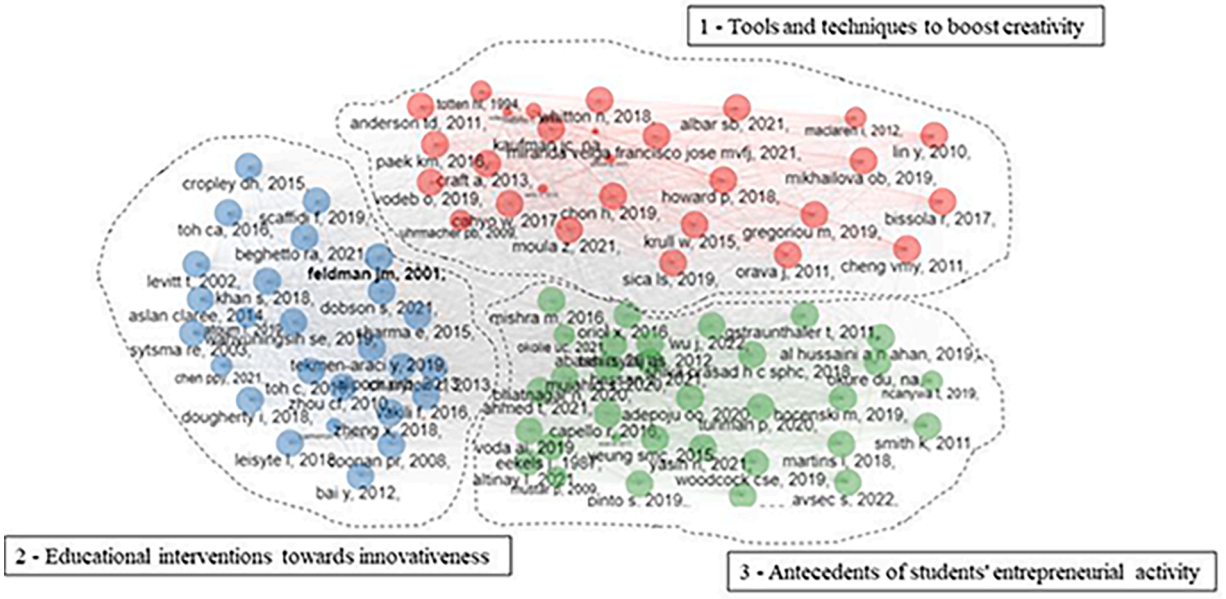

Fig. 5. Thematic clusters coupled by abstract content.

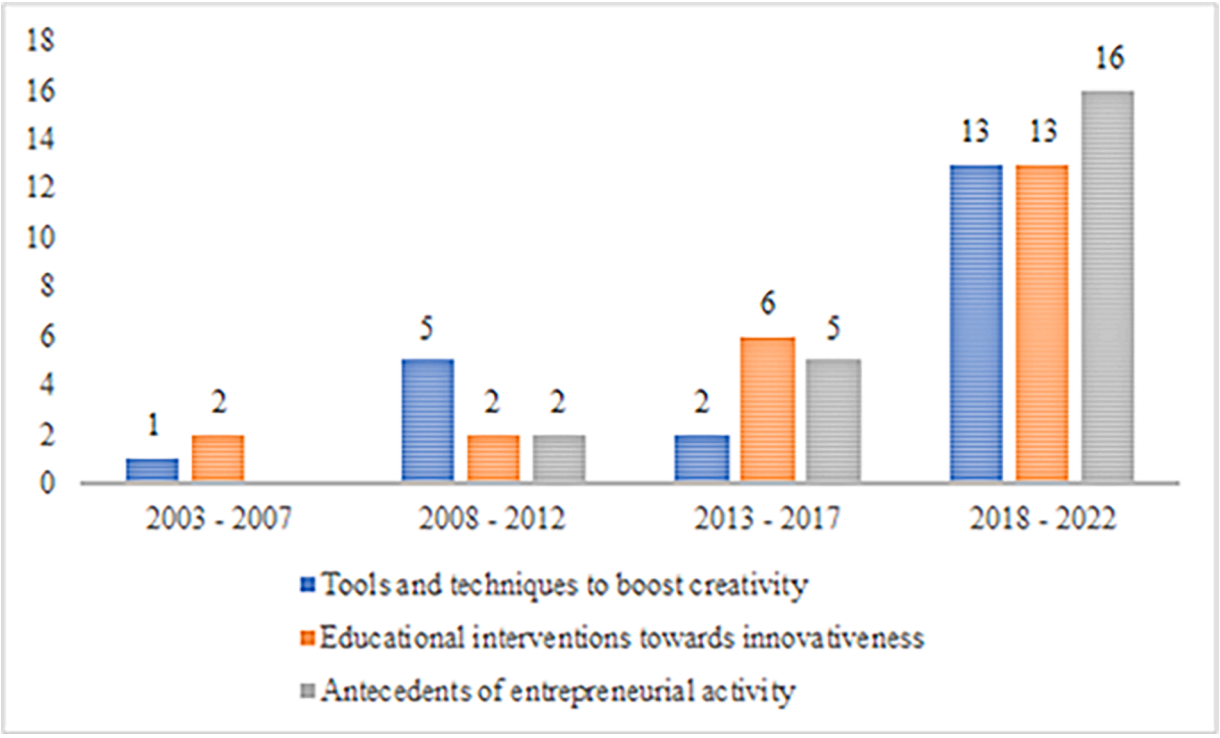

Fig. 6. Evolution of thematic clusters.

4.2. Research clusters and future research directions

By reviewing the literature on creativity and risk-taking stimuli in Education towards innovation, this study aimed to consolidate relevant research on a topic that has gathered significant attention. Our research found three main clusters of academic production. Their classification and internal contributions are discussed next.

4.2.1. Tools and techniques to boost creativity

Articles in this cluster presented several tools and experiments attempted to encourage risk-taking and creative thinking among different educational levels. The role of imagination must be highlighted as a room for expression beyond one's self. This was evidenced by the higher originality, imagination and creative thinking demonstrated by high-school students engaged in Multiplayer Online Role-Playing Games (MPORPG) (Mikhailova, 2019). According to Khan et al. (2018), online gaming platform technology may enhance student creativity and problem-solving abilities by inducing collaborative planning and decision-making.

Similarly, positive results were achieved when drama-oriented (role-playing) activities were tried among children (Lin, 2010), with self-reported improvements in playfulness, innovation, flexibility, space, and in-depth learning post-intervention. Although self-expression initiatives in childhood education might find fewer constraints, the study of Whitton (2018) presented a successful implementation of playful learning in an adult environment, indicating that such attempts are worthy and might be useful in organizational learning environments, in which people are expected to be creative, despite their background in dealing with risk-taking and self-expression practices. Indeed, theatrical features such as improvisation (Lemons, 2005) and interaction with historical imagination (Gregoriou, 2019) have been proved useful in assessing children's ability to develop new insights.

Even though Possibility Thinking (PT) is a determinant feature in creativity, the studies selected on this theme were performed with children aged 9–11 (Craft et al., 2013;Gregoriu et al., 2019), which opens a room of opportunities for greater debate on how this tool might help expand the horizons of older individuals (i.e. high-school and university students). Once again, risk-taking constraints are expected to become a moderator and results of such studies could bring important insights in the application of PT among young adults. A risk-taking approach tool such as Intelligent Fast Failure (Tahirsylaj, 2012) could precede this application by establishing a safe space for creation under a mindset that accepts failure as an intrinsic part of innovation (Table 5).

Contextual problem-solving was also addressed by several authors in the collection (e.g. Lemons, 2005; Cheng, 2011; Albar & Southcott, 2021). The results of the implementation of contextual problems integrated to teaching significantly impacted participants' creative processes in what concerns risk-taking, resilience, and creative thinking. For instance, when contextual problems were integrated into Science classes, students reported a sense of "active learning" (Cheng, 2011).

Another important aspect identified in the application of creativity boosting tools was the teachers' profiles. As an essential element in creativity encouragement in classrooms all over the education system, teachers' needs must be addressed. Anxiety levels, personal

Table 5
Tools and techniques to boost creativity.

	Author/year	Tool/technique	Participants	Outcomes
Tools and techniques to boost creativity	Mikhailova (2019)	Multiplayer online role-playing games (MPORPG)	High-school students	Participants involved in computer games were found to present higher originality, imagination and creative thinking than their peers not playing MPORPG.
	Veiga and Andrade (2021)	Unified Theory of Acceptance and Use of Technology (UTAUT)	Middle school teachers	The tools allow to diagnose teachers' current levels of technology acceptance, generating insights and new approaches that might increase the quality of teaching and learning
	Kaufman et al. (2021)	Intellectual Risk-Taking (IRT); Creative Mindsets Scale; Creative Trait Motivation Scale; Kaufman Domains of Creativity Scale–Short Form (K-DOCS-S); Creative Self-Efficacy (CSE; Creative Production–Verbal Task; Creative Production–Math Task; Divergent Thinking Task; ICID-S	Undergraduates	Academic achievement is not necessarily linked to creativity range. By exploring different creativity metrics, the authors discussed how standardized tests tend to undermine the role of creativity in the quality of intellectual thinking.
	Sica et al. (2019)	Utrecht-Management of Identity Commitments Scale and Test of Divergent Feeling.	Late adolescents	These tools confirmed the creativity-identity interplay in young people, indicating a need for creativity development in high-school to stimulate several personality traits linked to problem-solving.
	Albar and Southcott (2021)	Problem-and-project-based learning strategies	Children	The employment of the techniques significantly impacted children's creative processes in what concerns risk-taking, resilience, and creative thinking.
	Eekels (1987)	Basic design cycle and the structural model of the industrial innovation process	Engineering students	The generation of ideas precedes new product development by proposing several steps of verification: (a) goal setting; (b)problem analysis; (c) formulation of requirements; (d) generation of solutions; (d) simulation; (e) evaluation, and finally, (f) solution. Along with it, external variables and strategic orientation must be guaranteed by the industrial innovation process' steps.
	Lemons (2005)	Improvisation	Professionals	Individuals with higher skills in improvisation were also skilled in communication, community/teamwork, honest emotional expression, risk/challenge, safety, and self-actualization.
	Millard and Hargreaves (2015)	Centres for Excellence in Teaching and Learning (CETLs)	Higher education	CELTs play a central role in enhancing student creativity and exploring potential for innovation and, therefore, regional development.
	Cheng (2011)	Infusion approach (creative thinking taught within a context)	Middle-school students	Students were unanimous in the differences perceived when the technique became part of the classes, especially in an "active learning" sense.
	Craft et al. (2013)	Possibility Thinking (PT)	Children 9–11	Children were able to develop individual and collective dimensions of creative thinking, being able to share their ideas with others and have their own elaborations recognised.
	Gregoriou (2019)		Children aged 9–10	Interactive with historical artefacts (such as museums) help the aspiration of children's PT.
	Rerke et al. (2019)	Willingness to innovate	Teachers	Several constraints for teacher innovative initiatives were identified such as anxiety levels, risk-taking personal aversion and commitment to responsibility associated with risks.
	Howard et al. (2018)	Willingness to take risks	Teachers	The acceptance of risk among teachers and the development of a resilience to deal with failure are fundamental for sowing the same feelings in pupils.
	Lin (2010)	Drama-oriented activities	Children	Pupils participating in the experiment reported an increase in playfulness, innovation, flexibility, space, and in-depth learning.
	Uhrmacher (2009)	John Dewey's ideas from Art as Experience	Elementary school teachers	The features of active engagement, sensory experience, connections, imagination,

(*continued on next page*)

Table 5 (*continued*)

	Author/year	Tool/technique	Participants	Outcomes
				perceptivity, and risk taking tend to increase knowledge, student satisfaction, meaning making and creativity.
	Whitton (2018)	Playful learning	Adulthood	Adult playful learning might provide safe spaces for risk-taking and annulment of social constraints, thus leading to positive construction of failure as a mean to creation.
	Osorio et al. (2019)	Maturity grid-based assessment tool	University students	Exploring laboratories' strategies, capabilities, and network of stakeholders might optimize laboratory management of processes of creation, usage of space, and measurement of outcomes, thus benefiting students, researchers and professors.
	Tahirsylaj (2012)	Intelligent Fast Failure (IFF)	Not limited	IFF in educational environments could help acknowledge the need for failing attempts in the learning processes that lead to innovative breakthroughs.

Table 6
Educational interventions towards innovativeness.

Cluster	Focus	Author/year	Outcomes
Educational interventions towards innovativeness	Engineering	Atoum (2019); Charyton et al. (2013); Cropley (2015); Tekmen-Araci (2019); Toh and Miller (2016); Toh and Miller (2019); Zheng et al. (2018)	Lower cognitive risk-tolerance (tendency to mannerly behavior, conservative and narrow interests and cautious attitude)
		Cropley (2015)	Individual's attitude toward risk and their creative confidence in the generation and selection of ideas in engineering education are predictors of the selection of creative design
			Engineering courses struggle with gender diversity
			There is a tendency for overspecialization (too many subjects with shallow approaches)
			A lack of definition of what creativity really means is a challenge for curriculum planning
		Tekmen-Araci (2019); Cropley (2015)	Engineer instructors struggle with risk aversion to new educational approaches.
		Tekmen-Araci (2019)	The recognition of failure as a necessary stage in the learning and creativity processes is paramount.
		Zheng et al. (2018); Atoum (2019)	Concept selection tools are affected by human biases (mostly related to risk-aversion)
	Social Innovation	Bai et al. (2012); Beghetto (2021); Cameron et al. (2018); Vakilli et al. (2016)	Social issues (or recent disasters) can trigger young students' appeal for creative solutions through educational initiatives.
		Dougherty and Clarke (2018); Feldman (2001); Scaffidi (2019)	Young adults should be encouraged to participate in regional and social problem-solving through school and alternative institutions (e.g. NGOs).
	Health Education	Coonan 2008; Chen et al. (2021); Charyton et al. (2013); Chen et al. (2021); Charyton et al. (2013)	Risk aversion is a marked characteristic of Health majors. Design thinking efforts to generate more tolerance to ambiguity were well evaluated by medical students
		Dobson and Walmsley (2021)	Higher education institutions currently do not provide safe environments for experimentation and failure
	Post-graduation	Leišytė and Sigl (2018)	Bricolage activities and the trust of research managers in the leadership and autonomy of scientific entrepreneurs prepare the basis for institutional change.
	Business	Sharma (2015)	Business students scored low in conflict handling (collaboration), and risk taking and creative activities. Females were found to be higher in creativity, but males had superior performance in risk-taking skills.
	Fashion	Wahyuningsih et al. (2019)	Students become entrepreneurs through learning and experiences. Institutional efforts such as incubators might trigger Fashion alumni predisposition to venture.

aversion to risk and commitment to responsibility associated with institutional risks were some of the barriers disclosed for teachers' willingness to deal with risks implicated in innovation (Howard et al., 2018; Rerke et al., 2019). These results indicate that the process of educating for creativity must start with tools and techniques able to identify teachers' current levels of technological accessories and creative abilities, including their personal approach to risk (Uhrmacher, 2009; Veiga & Andrade, 2021). Articles' particular contributions are discussed in Table 6.

4.2.2. *Educational interventions towards innovativeness*

This cluster exhibits different approaches to the generation of ideas in multiple educational niches (see Table 6). First, it was reported that procreative attributes are not distributed evenly in all majors. There is a significant superiority in creativity potential in Social Sciences (Psychology/History/Political Science) and Arts (Art/ Architecture) when compared to Engineering, Education (e.g. post-graduation, as in Leišytė & Sigl, 2018), Health Professions, and Business (Coonan, 2008; Charyton et al., 2013; Tekmen-Araci, 2019).

Studies developed around Engineering (Atoum, 2019; Tekmen-Araci, 2019; Toh & Miller, 2019), Biology (Aslan et al., 2014), and Nursing students (Coonan, 2008) report a general disregard for risk-taking. A similar conclusion was achieved with Business students (Sharma, 2015), who exhibited average scores on conflict-handling (collaborations) and risk-taking. As a consequence, a series of interventions were attempted to generate creative outcomes in Engineering classes (e.g. Cropley, 2015; Zheng et al., 2018; Atoum, 2019). These experiments revealed some major constraints in individual creativity in the area due to (a) conservatism, narrow interests, and excessive caution (Charyton et al.; 2013; Toh & Miller, 2019); (b) lack of gender diversity (Cropley; 2015); (c)over-specialization (many subjects explored in little depth) (Cropley; 2015), and (d) engineering instructors being risk-averse and not opened to new teaching approaches (Cropley, 2015; Tekmen-Araci, 2019).

As for Health-related courses, the application of design thinking have reportedly led medical students to achieve improvements in important creative features such as: "uncertainty, embracing risk, human-centeredness, mindfulness and awareness of process, team knowledge, experimentation, transforming in something tangible, abductive thinking, envisioning new things, and creative confidence" (Chen & Chou, 2021, p. 3).

This cluster also evidenced the importance of contextualizing social issues in the classroom in order to develop students' problem-solving skills. The study of Bai et al. (2012) explored how university engagement in ideas to reduce power wastage post-Fukushima disaster triggered student creativity and problem-solving. In a similar fashion, Cameron et al. (2018) and Beghetto (2021) describe how deeply troubling periods of disaster (e.g. Christchurch's 2016 earthquake, and the COVID-19 pandemic, respectively) may awake an entrepreneurial spirit, encouraging risk-taking and collaboration, which leads to new ideas, new mindsets, and the formation of different leaderships. These scenarios can be opportunities for the youth to reinterpret their pain by generating solutions. As individuals who are at the peak of brain capacity and ability to experiment and explore, the young can significantly contribute to discussions on regional development (Dougherty & Clarke, 2018; Scaffidi, 2019; Vakilli et al., 2016) if provoked to do so. That should not mean, however, they have to face the "dark path" of risk-taking on their own. Intergenerational support, diversity, and mentoring are vital elements to obtain positive results whilst collectively solving issues (Dougherty & Clarke, 2018), especially in more vulnerable communities or small towns that do not count on university-led innovation (Feldman, 2001).

4.2.3. *Antecedents of entrepreneurial activity*

This cluster presents articles that show initiatives directed to develop students' entrepreneurial skills. Differently from the two previous clusters, documents in this collection reported actions and measurements related not only to the generation of new ideas, but to the next step, i.e. turning them into a proper business. Although it would be expected from Business schools to provide platforms for entrepreneurship as a core value of their institutional aims, the reality paints a very different picture (Gstraunthaler & Hendry, 2011).

Several studies investigated the antecedents for entrepreneurial action by students, revealing that technical and professional training indeed increase individuals' innovation, creativeness, flexibility, perseverance, optimism, and providence (Abassi, 2013; Altinay et al., 2021; Avsec et al., 2022). An important aspect of this cluster that goes beyond the traditional aforementioned tools (meant for innovation) is the identification of funding support, mentoring, cash and time management, and financial management learning (Smith & Beasley, 2011; Al Hussaini, 2019; Ahmed et al., 2021) as skills seen by students as essential for taking a leap towards venturing. Moreover, institutional features such as teaching methods that incorporate contemporary issues (Yeung, 2015), university-industry collaboration, and infra-structural capacity must be in place to evoke students' entrepreneurial intention (Adepoju & Nwulu, 2020). These institutional efforts should also be accompanied by competent teachers well versed in entrepreneurship and able to provide students with realistic industry exposure (Yeung, 2015). Moreover, the use of the socio-scientific argumentation method could be incorporated in lectures in order to form a new perception of entrepreneurship (Turiman et al., 2020; Özcan and Balim, 2021). Such efforts could also include regular mentorship activities with industry experts and advisors (Smith & Beasley, 2011).

Risk-taking abilities seem to play the most important role when it comes to engaging in entrepreneurial activities according to several authors. Altinay et al. (2021) found risk-taking propension to be the variable with the strongest correlation to entrepreneurial intention. Similarly, Martins et al. (2018), Shiva S.H. Prasad et al. (2018), and Pinto et al. (2019) identified self-confidence and fear of failure as determinants for students to develop an entrepreneurial orientation. This evokes debates on whether taking risks at an entrepreneurial level is essentially a psychological feature that cannot be significantly impacted by technical training (Abassi, 2013; Shiva S.H. Prasad et al., 2018, Woodcock et al.; 2019). Cultural characteristics have also been strongly linked to entrepreneurial intention (Wu, Alshaabani & Rudnák, 2022), which might indicate that cultural environments impact students' views of risk-taking, thus fostering or restraining the likelihood of venturing in a given society. Furthermore, discussing venturing risks may elicit more in-depth discussions on students' emotional creativity and the development of educational strategies to deal with students' short span

Table 7
Antecedents of entrepreneurial activity.

Cluster	Level	Author/year	Outcome
Antecedents of entrepreneurial activity	Higher education	Abassi (2013), Yeung (2015); Cahyo et al. (2017); Adepoju and Nwulu (2020); Wu, Alshaabani and Rudnák (2022);Ahmed et al. (2021); Al Hussaini (2019); Martins, Monslave and Martinez (2018); Ncanywa (2019); Oriol et al. (2016); Pinto et al. (2019); Prasad et al. (2018); Okure (2022)	Technical and professional training (e.g. in creativity, risk and financial management), along with institutional efforts (universities' own organizational culture), emotional support, morality reinforcements, and partnerships are crucial for students' EI.
		Yasin and Khansari (2021)	Venture-oriented programmes might have different effects on male and female students, especially on risk-taking measures.
		Mishra, Garg and Nagpal (2016); Cahyo et al. (2017); Altinay et al. (2021); Ahmed, Klobas and Ramayah (2021)	Besides creativity, risk-taking propensity, stress tolerance, self-reliance, hard-working mentality, and innovativeness were also found to be positively related to EI.
		Woodcock et al. (2019)	While sponsors may play an important role in funding, their interests might restrain Engineering students' creative skills and problem-solving abilities.
		Krull (2015); Hassan, Lashari and Basir (2021)	Risk-taking, creativity, and innovation can be encouraged through a strengthened entrepreneurial culture. Additionally, researchers require a certain level of professional security to engage in projects of innovation that might take longer to proper than what is expected by public and private investors.
		Avsec et al. (2022)	Design-based-learning and guest speakers or employment scouts have positive effects on students IE.
		Pinto et al. (2019); Yeung (2015); Smith and Beasley (2011); Gstraunthaler and Hendry (2011)	Entrepreneurial education should better prepare students to face social and political aspects (barriers) of venturing.
		Ncanywa (2019); Yeung (2015)	It is paramount for regional development that the whole education system fosters an entrepreneurial mindset in students.
		Okolie et al. (2021)	Compulsory participation in pro-entrepreneurial programmes in higher education is of questionable effectiveness.
		Turiman et al. (2020)	Science students should be encouraged to pursue entrepreneurial thinking.
	High school	Amiri and Doodman (2017)	Creativity is over prioritized in high school textbooks, leaving other EI traits overlooked.
	Middle school	Özcan and Balim (2021)	The socio-scientific argumentation method positively affected students' perception on entrepreneurship.

of attention by generating novel emotional experiences in the classroom (Oriol et al., 2016). However, it is important to be aware of the chance of failure of such initiatives for a significant number of students, especially when the developed programs to foster entrepreneurship are compulsory (Okolie et al., 2021). Not all Business students are prone to entrepreneurship as not all of them count on the same risk-taking and creativity background, which might point to the need of offering venture-oriented programs as extracurricular activities. Notwithstanding, more studies are required to attest the failure of compulsory models. Article's main outcomes are detailed in Table 7.

5. Discussion & conclusion

For the first part of this study, records were extracted from Scopus and Web of Science databases containing a set of strings linking creativity, risk-taking, innovation, and education. After several filters and further reading of articles' full content, 86 documents were selected for bibliometric analysis. Due to accessibility, 79 of these documents were included in the phase of content analysis.

Results indicate that the interest and, hence, the number of publications in the topics has increased greatly in the last five years. Although the first publication in the collection dates back to 1987 (Eekels, 1987), it was not until 2011 that the subject received more attention. Nevertheless, publications are still concentrated in a few journals (specially Thinking Skills and Creativity, Art Design & Communication in Higher Education, and Psychology of Aesthetics Creativity and the Arts) and in developed and English-speaking countries (USA, UK, Australia and Canada). Colombia is the only Latin American country to figure in the top 10 list. The majority of studies recognize the importance of including creativity in all levels of education, from elementary schools to higher education, including teacher training. The means to do it vary greatly, from online gaming to dramatization and role-playing, but all showing positive results. Risk-taking activities and stimuli to generate new ideas and entrepreneurial activity happens across all areas, but with a higher intensity in the Social Sciences and Arts.

As recognized previously by several authors (Christensen et al., 2021; Leahey et al., 2017; Vidmar, 2019), interdisciplinarity is key in the formation of more creative and problem-solving-oriented individuals. The sharing of findings, tools, approaches and new theoretical perspectives might lead to tremendous advances in societal innovation. Besides, risk-taking has been revealed to be a multifactorial phenomenon, with mixed results in gender experiments, but with solid findings in the role of culture as a water divider.

This notion is in tune with the involvement of Psychology-related journals with the thematic here discussed. It seems unlikely that risk-taking in Business and other areas will be detached from behavioural studies. From individuals' upbringing to societal pressures towards success and stability, risk represents more than a possibility of failure for certain ventures. It means a debacle of an individuals' dreams and aspirations, along with peer and parental reproach. Therefore, developing the ability to learn from failure and to assume this possibility with the correct mindset can and should be an elementary skill to be developed in all stages of the education system.

This study pictures entrepreneurial education as a field that is still in its infancy and, thus, provides several opportunities for research and education policies and programs design. For a start, it is surprising that among business-related areas, only Engineering and Design have loomed. The research findings pointed to three main clusters of academic production: (i) Tools and techniques to boost creativity; (ii) Educational interventions towards innovativeness; and (iii) Antecedents of entrepreneurial activity. There are two relevant fields that can be considered Motor Themes for education policies and programs: "social innovation, design education, and design thinking" and "education, design, and design process". Both research areas point to the dominance of design as a central vehicle to creativity and innovation diffusion.

This study pictures a field that is still in its infancy and, thus, provides several opportunities for research. For a start, it is surprising that among business-related areas, only Engineering and Design have loomed. What efforts are being made in Business Administration education? How is higher education in Business coping with the elements of risk-taking and creativity in the classroom? Has any large educational player explored this gap so far? If not, how could they? What protocols could be employed to make Business students more skilled in problem-solving and innovation beyond optional lectures?

In the realm of tools and techniques, there are plenty of opportunities to experiment with successful alternatives employed by Arts and Social Studies in other fields of research that struggle with creativity (e.g. Health Sciences and Engineering). As for entrepreneurial education, it could be interesting to explore how elementary and high school individuals feel about starting a business and providing solutions to society. Playful activities developing a sense of ownership and creative venturing could lead children and adolescents to explore their potentials along with a sense of meaning associated with becoming an entrepreneur. The mental barriers and negative impressions on venturing could be also perceived in these groups of people, leading to important insights on how societal standards affect individual entrepreneurial intention from an early age.

Limitations and future research

This study contains several limitations due to the search strings adopted and the angles chosen to approach the theme. First, studies that did not relate all three variables of interest - creativity, innovation, and risk – were not included, damaging possible marginal contributions. Besides, it should be noted that seven documents could not be obtained due to university credentials not allowing access to such files and/or authors/co-authors not having replied to our e-mails. It is also worth of mention that conference proceedings were not present in this paper due to controversies on peer-review validity. Given the emergence of the subject and the broad perspectives for further exploration, we highly recommend that future studies in this theme make the maximum use of interdisciplinary approaches and cross-country collaboration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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