Street Art & Urban Creativity | Vol. 11, No. 4, 2025 | ISSN 2183-9956
Street Art & Urban Creativity. Scientific Journal
https://doi.org/10.62161/sauc.v11.5799

CREATIVE THINKING IN THE PISA-2022 TESTS
Implications for Building Creative Cities in Colombia

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KEYWORDS

Creative Thinking
Measuring Creativity
PISA Tests
Colombia
Education

ABSTRACT

Measuring and applying creative thinking was one of the major goals of authors who, in the mid-20th century, proposed various studies aimed at understanding the brain and its relationship with creative thought. Among them were Guilford (1967), Torrance (1974), and Gardner (1983), whose research promoted the measurement of creativity. By the second decade of the 21st century, the objectives of these early authors become evident with the incorporation of a specific test for assessing Creative Thinking in the PISA 2022 assessments, applied to students in OECD member countries who are 15 years old at the time of testing, regardless of their grade level. Based on the design characteristics of the test and its results, this paper analyzes the implications for Colombia and the development of Creative Thinking in its young citizens and for the nation as a whole.

Received: 01 / 03 / 2025
Accepted: 25 / 06 / 2025

1. Introduction

1.1. Emergence and Measurement of Creative Thinking

The objective of quantifying various aspects of life emerged during the Industrial Revolution. During this period, scholars and scientists initiated the establishment of means for a wide range of phenomena, encompassing both physical (e.g. natural phenomena, chemicals, anthropometry) and psychic aspects. Consequently, human intelligence became subject to this paradigm. The manner in which it was manifested, or lacked, as well as the elements to which exceptional conditions were attributed, were of interest to science. In this context, at the beginning of the 20th century, the process of schooling was advancing rapidly in different countries of the global North and South. In a number of these countries, children were reported to have learning difficulties, such as being unable to keep up with their peers or experiencing difficulties in learning. However, at the time, there were no tools for measuring cognitive abilities. The French government thus commissioned the psychologist Alfred Binet (1857-1911) and the psychiatrist Theodore Simon (1872-1961) to develop an instrument to identify students who had learning difficulties and were not benefiting from the education system, with a view to providing them with alternatives appropriate to their needs.

In 1905, Binet and Simon presented their initial intelligence scale, which corresponded to a set of tests for the evaluation of cognitive skills such as: The cognitive abilities of the subject under investigation were measured using a series of tests designed to assess memory, language, reasoning and comprehension skills. In addition to providing information on these cognitive skills, the results of the tests allowed the estimation of the subject's mental age. This was achieved by generating an average of the skills that a minor of the same chronological age could solve. Regarding cognitive skills, the following variables were measured:

- Memory: The ability to recall a series of numbers, words or images.
- Language: Assessment of broad knowledge of vocabulary and the meaning of words.
- Reasoning: Measurement the ability to establish logical relationships between elements and to solve problems.
- Comprehension: Measurement of the ability to understand and respond to questions regarding quotidian scenarios.

At the beginning of the 20th century, the prevailing needs of Binet and Simon centred on the identification of children with learning difficulties. They subscribed to the notion that intelligence is a capacity that can be cultivated and that education should be tailored to the individual needs of each child. Concurrently, the intelligence test served as a means of countering the prevalent eugenic theories that were subsequently adopted and implemented by political and military movements. Despite the intelligence test's extensive criticism and the development of alternative formulations, the concept of assessing higher cognitive processes persists. By 1916, Lewis Terman had adapted Binet and Simon's test into the Stanford-Binet Scale, which subsequently gained global popularity. For Lewis Terman, the most significant changes were centred on the broadening of the tasks to be measured and the adaptation to the population of the United States. The incorporation of the intelligence quotient (IQ), which gained popularity throughout the 20th century and has been subject to criticism on the grounds that it generates conditioning factors, as well as another of the new factors of the test was the incorporation of the general intelligence factor (g), which makes it possible to evaluate an intellectual capacity underlying all cognitive abilities.

In relation to the g-factor (general intelligence factor) proposed by Charles Spearman (1863-1945), his research suggested the existence of a single general factor (g-factor) that influences all cognitive tasks. The scientist also indicated that there are specific factors that relate to specific tasks or particular abilities of each individual. These two factors constitute the Bifactor Theory of Intelligence, proposed by Spearman, which led the scientist to propose intelligence as a single unitary construct. That is to say, intelligence is not separate abilities but is controlled by a central

capacity. This final aspect has been the subject of considerable criticism, with Spearman's approach being accused of ignoring the intricacies and variety of cognitive abilities. This has led to the work of prominent psychologists such as Thurstone and Howard Gardner, who studied various cognitive domains and demonstrated that performance in these areas cannot be attributed to a single, generic and unique ability.

This prompted other scientists to develop scales with greater precision or that encompassed a broader range of aspects (Runco, et al, 2012) . An exemplar of this is David Wechsler (1896-1981), who, in 1939, proposed the Wechsler-Bellevue Intelligence Scale. This scale incorporated the measurement of the Verbal Quotient, which evaluates elements related to the use of language, such as verbal reasoning, verbal memory and information comprehension. In contrast, the Execution (or Non-Verbal) Quotient is a measure of skills related to the manipulation of objects, the ability to react quickly, and visual and spatial problem solving. Wechsler's approach was revolutionary in its inclusion of global measurement patterns of intelligence, in addition to specific patterns. This inspired other psychologists, such as Louis Leon Thurstone (1887-1955), to propose a theory that assesses multiple factors of intelligence. This theory challenges the concept of the "g-factor" or general intelligence factor, proposing that intelligence is the set of cognitive abilities that function relatively independently. The American scientist identified seven primary mental abilities:

- Memory: the cognitive faculty that enables the retention and recollection of information.
- Verbal Comprehension: The capacity to comprehend the significance of words and complex texts is a fundamental skill in any language learning context.
- Verbal fluency: the capacity to articulate words expeditiously.
- Numeracy: The capacity to engage in computations and mathematical operations is a prerequisite for this course.
- Spatial ability: The ability to visualise and manipulate objects in space is also a key component of the discipline.
- Perceptual speed: The ability to swiftly identify and interpret information from visual patterns is a key cognitive skill.
- Inductive Reasoning: The ability to identify logical patterns and to draw generalisations or conclusions from the analysis carried out is of the essence.

The aforementioned competencies enabled L.L. Thurstone to propose the Multifactor Theory of Intelligence, which subdivided the factors to be evaluated and proposed a more diverse cognitive profile of the individuals measured with the test. The multifactorial proposal initiated a framework within which psychologists specialising in diverse thinking skills could propose the measurement of psychometric tools, including creativity. In this field, the psychologist Joy Paul Guilford (1897-1987) was among the first to examine the relationship between intelligence and creativity, proposing the Structure of Intellect Model. Guilford's seminal contributions to the field of psychology include the conceptualisation and differentiation between Convergent Thinking and Divergent Thinking, which were two fundamental categories for identifying the functioning of Creative Thinking and the skills involved in it (Guilford, 1950).

Guilford (1956) proposed a three-dimensional model known as the Structure of Intellect Model (SOI), which conceptualises the following dimensions:

- Operations: The following mental processes are utilised: cognition, memory and thinking (convergent and divergent).
- Content: The information with which we operate encompasses visual, semantic, symbolic and behavioural information.
- Products: The results obtained from the application of the operations to the contents are as follows: units, classes, relations, systems, transformations and implications.

Guilford's analysis encompassed a comprehensive array of over 150 distinct factors of intelligence, in addition to factors specific to creativity, including: Fluency of ideas, flexibility in the use of concepts and the capacity to generate original responses. The fundamental characteristic of the tests designed by Guilford is the ability of an individual's response to a single stimulus to generate or produce multiple ideas or solutions. In this sense, the Verbal Fluency test is based on the ability to generate as many ideas or words as possible within a limited time frame. The Flexibility test is based on the ability to change the approach to problem-solving from different perspectives. The Originality test is based on the ability to produce unusual or innovative ideas. Guilford's seminal contributions to the field of creativity research, as outlined in the following categories, represent a substantial advancement in the understanding of creativity and mental processes. Noteworthy is the shift from a behaviourist model, which dominated in the first half of the 20th century, to a more cognitively-oriented approach, anchored in the principles of cognitive psychology (De Bono, 1994).

A significant proportion of these categories were explored by E. Paul Torrance (1915-2003), who developed a test to assess creative thinking known as the Torrance Tests of Creative Thinking (TTCT). This test has made a substantial contribution to the establishment of creativity as a field of research and legitimate study, resulting in creativity diverging from studies on intelligence and expanding its scope in educational, business and professional domains. Torrance's contribution to Guilford's theoretical framework lies in the introduction of a fourth category, Elaboration. This category was defined as the capacity to evolve ideas, incorporating intricate details. The integration of this fourth category into Guilford's existing taxonomy of creativity (Originality, Flexibility, and Fluency) enabled a standardized measurement of creative output.

Torrance's Test of Creative Thinking (TTCT) is a comprehensive assessment tool designed to evaluate divergent thinking in various domains. The test comprises a series of exercises encompassing both verbal and non-verbal tasks, with the objective of measuring four distinct aspects of creative thinking: fluency, flexibility, originality, and elaboration. These aspects are assessed through tasks such as completing figures, enhancing existing products, and engaging in creative word association. Torrance also advanced the theoretical framework pertaining to the creative process, which he categorised into four stages corresponding to:

- Problem sensitivity: This is the identification of a discrepancy, challenge or challenge that can be addressed.
- The generation of ideas: This process entails the conceptualisation of multiple solutions or ideas for problem resolution.
- Evaluation: This process involves the analysis and selection of ideas that have the potential to contribute to the identification of solutions to the problem.
- Communication of ideas: This process entails the identification of efficacious methodologies for the articulation or dissemination of the creative solutions that have been formulated.

In a similar vein, Howard Gardner (1943-present) has contributed to the epistemological construction of creativity by proposing that intelligence is not a single general capacity, thus countering Spearman's position. As posited by Gardner (1983), creativity is conceptualised as a multifaceted cognitive ability that facilitates diversified cognitive processing, contingent upon the nature of the stimulus administered to the nervous system. Among the plurality of intelligences described by Gardner are: Subsequently, the psychologist advanced a ninth intelligence, designated Existential Intelligence, alongside the original eight: Linguistic Intelligence, Logical-Mathematical Intelligence, Spatial Intelligence, Musical Intelligence, Bodily-Kinaesthetic Intelligence, Interpersonal Intelligence, and Naturalistic Intelligence. The central argument of this theory is that different types of intelligence enable different types of creative expression. In the context of assessments designed to gauge creativity, Gardner proposes that a narrow, standardised approach to intelligence, as measured by IQ or divergent thinking tests, is insufficient. Instead, he advocates a more nuanced approach, emphasising the necessity of administering specific tests tailored to each distinct type of intelligence.

Gardner's work was influenced by a number of interdisciplinary fields, including cognitive psychology, anthropology and neuroscience. Through his observations of various cultures, the scientist noted that in some societies, problem-solving and artistic abilities are held in the same esteem as logical and mathematical aptitudes. This observation led Gardner to challenge the Western notion of logic as being dominated by one particular form of intelligence. In a similar manner, the present author has contributed to the expansion of the concept of creativity beyond the artistic domain, thereby recognising creativity and its manifestations in fields such as mathematics, natural and physical sciences, human relations and everyday problems. This has resulted in the diversification of the concept of creativity to encompass a wider range of fields and scales of the human.

2. Measuring Creativity from the PISA Test

The Programme for International Student Assessment (PISA) is an international assessment which measures the knowledge and skills of 15-year-old students from different countries. The assessment programme is overseen by the Organisation for Economic Co-operation and Development (OECD, 2023b) and is conducted on a triennial basis. The genesis of the programme can be traced back to 1990, when the necessity for a more robust approach to the evaluation of educational systems and the enhancement of economic competitiveness among nations in a rapidly interconnected global landscape first emerged. However, it was not until the year 2000 that the programme came into its own. Despite the evident correlation between education and economic and social development, there was no instrument that would allow for a comparison between countries and enable analysis under reliable and objective parameters. This assessment tool provides governments with data for decision-making and policy-making (OECD, 2023c).

The overarching objective of the PISA tests is to evaluate the degree to which students are prepared to contribute to the knowledge society, encompassing not only their proficiency in specific domains such as science, reading comprehension, and mathematics, but also their ability to apply this knowledge to address real-life problems (Elisondo et al., 2016). In addition to the aforementioned, the tests provide information on differences in performance between students from different socio-economic backgrounds.

One of the characteristics of the tests is that all three areas (science, reading comprehension and mathematics) are applied, but each cycle focuses on one area in a dominant way. In addition to these three areas, two cross-cutting areas, namely collaborative problem solving (starting in 2015) and global competencies (starting in 2018), are assessed. These two areas make up the entire test.

The 2021 iteration of the test was postponed to 2022 due to the impact of the pandemic, which resulted in the closure of educational institutions in several countries, thereby hindering the participation of relevant stakeholders. In this iteration of the assessment, the test was administered to 690,000 15-year-old students across 81 participating countries (OECD, 2023a). In the case of the secondary test on creative thinking or assessment of innovative mastery, it was applied to 66 countries, the results of which were published by the OECD in 2024, grouped in Volume III: Creative Minds, Creative Schools (OECD, 2024b). In the case of Financial Literacy, Volume IV (OECD, 2024a), a voluntary test for young people and countries, the characteristics of the different tests are presented below.

Table 1. Typology of PISA Tests and their Characteristics

Test Type	Test Characteristics
Mathematics	It assesses the ability to reason, formulate and solve problems by applying mathematical concepts in everyday situations.
Reading Comprehension	Assesses the ability to interpret, use and reflect on information from different written texts.

Science (Scientific Literacy)	It assesses the ability to solve scientific problems, make predictions and make decisions based on scientific data that enable them to understand the world around them.
Collaborative Problem Solving	It assesses the ability to share information, work in teams, negotiate and develop solutions in collaboration with others.
Global Competence	It assesses the ability to understand and analyse global issues, appreciate the perspectives of others and communicate effectively.
Creative Thinking	The ability to productively generate, evaluate and improve ideas that can contribute to original solutions and that can lead to new knowledge and expressions of the imagination.
Financial Literacy	It is the knowledge and understanding of financial concepts and risks associated with financial products. It seeks to assess the identification of financial information, analysis of financial information and contexts, evaluation of financial issues, applying knowledge and understanding of finance.

Source: Own elaboration, based on information from OECD, 2023a.

In contrast, the PISA test has undergone a series of modifications over time, encompassing both fundamental and secondary domains of knowledge. Specifically, the creative thinking test has been adapted within the context of an increasingly demanding knowledge society, where capacities and skills for adaptation, flexibility, and transformation of society through innovation are paramount. "It has also been found to support a variety of other important aspects of student development and performance" (OECD, 2024). For the PISA 2022 test, creative thinking is defined as "the competence to engage productively in generating, evaluating and improving ideas that can lead to original and effective solutions, advances in knowledge and powerful expressions of the imagination" (OECD, 2024). The following table is presented in order to facilitate the understanding of the necessary context on the chronology of appearance of each of the tests, the number of participating countries and the focus on the specific field.

Table 2. PISA Test Chronology

Starting year	Appearance of Evidence and Approach	Number of participating countries
2000	First cycle of PISA test, with focus on Reading Comprehension	43 (32 in 2000 and 11 in 2002)
2003	Focus on Mathematics	41
2006	Focus on Science	57
2009	Focus on Reading Comprehension	75
2012	Focus on Mathematics	65
2015	Focus on Science, the cross-cutting test in Problem Solving is incorporated.	72
2018	Focus on Reading Comprehension, the cross-cutting test of Global Competence is incorporated.	79
2021 (change to 2022)	Focus on Mathematics, the application period is changed due to COVID-19 to 2022. A chapter on *Financial Literacy (optional area for youth and countries,* 23 countries participated in the questionnaire*)*, and another one on *Creative*	81

	Thinking (secondary assessment area, 64 countries participated in the questionnaire*)* are added.	

Source: Own elaboration, based on information from OECD,2023a.

In the case of the test, two aspects related to creativity were taken into account: creativity with a capital 'C', which is commonly associated with great technological or cultural advances, and creativity with a small 'c', which is related to everyday creativity (Csikszentmihalyi, 1996). For the PISA 2022 measurement, three ideation processes were considered, and students' ability in these areas was assessed: a) Generating diverse ideas; b) Generating creative ideas; c) Evaluating and improving ideas.

Table 3. Ideation processes in the PISA 2022 tests assessed in the creative thinking test

Ideation Process	Description	Number of items assessed
Generating Diverse Ideas	Ability to think flexibly by generating different ideas from each other. Two categories were assessed: *Ideational fluency* (total number of ideas generated) *Ideational flexibility* (how different the ideas are)	12
Generating Creative Ideas	Ability to think outside the box. It is referred to by Guilford (1950) as "statistical infrequency" and is associated with novelty, rarity, remoteness. This aspect is measured in relation to other students taking the test; the more students indicate the same idea, the more original the answer is considered to be.	11
Evaluating and Improving Ideas	Ability to evaluate the limitations of an idea and propose improvements based on originality. The identification and the way in which new options for improvement are proposed are evaluated, taking into account that the solutions are appropriate, adequate, efficient and effective (Cropley, 2006).	9

Source: Own elaboration, based on information from OECD, 2024b, Volume III.

The test is designed to assess four domain contexts or typologies of formats, which are outlined below: The students were required to complete a total of 32 tasks, which included 12 items of written expression, 4 items of visual expression, 10 items of social problem solving, and 6 items of scientific problem solving. These items contribute to the assessment of creative thinking and the exploration of the different effects of teaching and learning strategies that are implemented in the classroom or that are included in the curricula of schools and colleges. The following elements are assessed in the tests:

Table 4. Items Assessed in the PISA 2022 Creative Thinking Tests

Domain context	Description	Formats	Number of items assessed
Written Expression	Through written language the student must communicate his or her ideas and imagination.	Image captions. Ideas for a story. Writing short dialogues.	12

		Write a story with a given piece of information.	
Visual Expression	Through different media the student will communicate their ideas and imagination.	Creating visual compositions from a library of images	4
Social Problem Solving	Addressing the needs of others, understanding different perspectives and finding innovative and functional solutions.	Create categories and subcategories of ideas	10
Scientific Problem Solving	Propose new ideas, design experiments to test hypotheses and develop new methods and inventions to solve problems.	Generate multiple ideas or solutions to unanswered open problems.	6
Total items			32

Source: Own elaboration, based on information from OECD, 2024b, Volume III.

The PISA-2022 test is designed to evaluate the mobilisation of cognitive processes, with the objective of fulfilling achievements that are focused on the generation, evaluation and improvement of ideas. Nonetheless, it is imperative to elucidate that the creative thinking test, which comprises a total of 32 tasks, is characterised by the presence of open-ended questions. This design of the test engenders a situation in which the potential answers are virtually limitless. Consequently, the evaluation process was conducted by human assessors who, according to the detailed scoring rubric, awarded points to the most original answers, ranging from a total to partial or no points. In this regard, current research indicates that creative thinking can be fostered through knowledge communities. That is to say, knowledge communities are effective when schools operate as active knowledge builders and integrate knowledge into classroom life. This is largely what the test seeks to measure in each of the domain contexts.

3. Creative Thinking Performance in Colombia's PISA-2022 Test

The creative thinking assessment for Colombia yielded information regarding students' aptitude for integrating knowledge in problem-solving, as well as their level of preparedness to think innovatively in order to generate creative solutions that can be applied to diverse contexts. Colombia attained an average score of 26 out of a maximum of 60 points, a figure significantly lower than the OECD average, and was placed 28th out of 64 countries participating in the test. Conversely, the report Volume IV-OECD, (OECD, 2024a) indicates that Colombia has outperformed expectations, particularly in the context of the results of the mathematics and reading comprehension tests. A total of 7,804 students from 262 schools completed the test, yielding the following findings.

In the Colombian case, students demonstrated a basic level of competence in creative thinking (55%), while the OECD average is 78%, Volume IV-OECD, (OECD, 2024a). Conversely, only 12% of students in Colombia demonstrated a high level of performance in creative thinking, whereas the OECD average was 27%. The findings further demonstrate that 2% of students who exhibited high performance in creative thinking also demonstrated high performance in mathematics, while 6% demonstrated high performance in reading. In contrast, the OECD average ranges from 20% to 17%. In this respect, the country exhibits below-OECD-average performance in a range of areas.

This finding poses challenges for the development and implementation of effective public policies, as well as for the operational processes within the academic sphere.

In relation to the test and its three specific measurement/ideation domains (i.e. generating diverse ideas, generating creative ideas and evaluating and improving ideas), students scored higher in the second component (generating creative ideas) compared to other results. In contrast, in most participating countries, the ideation process with the highest level of difficulty was generating diverse ideas. With regard to the domain contexts of written expression, visual expression, social problem solving and scientific problem solving, students exhibited higher levels of proficiency in tasks pertaining to the domains of written expression and visual expression.

The study also established that socio-economically advantaged students outperform disadvantaged students by 11.5 points on a 60-point scale, while the OECD a maximum performance gap of 9.5 points is observed between advantaged and disadvantaged students. A notable finding is that 11% of disadvantaged students in Colombia were classified as "resilient creative thinkers," a term used to denote those who have attained exceptional results despite their socio-economic disadvantage. This is in comparison to the achievements of their peers in Colombia. The OECD average for this aspect is 13% of disadvantaged students achieving high scores in creative thinking despite their socio-economic disadvantage, compared to students in their own countries.

In addition, girls demonstrate, on average, a 1.6-point higher performance in creative thinking than boys. In contrast, the OECD average is 2.7 points lower, which is a significant difference. Notably, in this domain, no country has recorded a higher performance among boys in comparison to girls. In the highest performance category (Level 5-6), which corresponds to the highest results, the proportion of girls is significantly higher than that of boys. Specifically, 13% of girls are at these levels, while only 11% of boys are, indicating a notable gender disparity. The OECD average for this category is 31% and 23%, respectively, reflecting the observed differences in performance between the two genders. In the other extreme category are students who do not reach level 3 (the basic level in creative thinking). This level corresponds to 49% of boys who do not reach it, while for girls it is 42%. The OECD average for these levels is 25% and 18%, respectively.

In relation to the results presented above, it is possible to indicate that there are various factors that can affect performance, which, although they cannot be attributed exclusively to them, can offer a guide to the analysis of the results of the test related to creative thinking in Colombia. The following factors were identified:

3.1. Socio-economic level

Students from affluent families possess a greater quantity of economic and cultural resources, which enables them to demonstrate higher levels of creative performance in comparison to students from less privileged backgrounds. However, the findings of the study underscore the notion of "resilient creative thinkers," individuals who, despite facing disadvantages in terms of socio-economic status, demonstrate remarkable aptitude, thereby underscoring the potential for enhancement. This observation calls for the formulation of strategies aimed at leveraging educational policies to further bolster and expand this demographic.

3.2. Quality of education

Although it is evident that schools with superior resources and more qualified teachers can achieve superior results compared to those lacking these factors, it is important to identify apparently exceptional behaviours such as the one presented by resilient creative thinkers. Furthermore, there is a need for more aggressive public policies to promote creative thinking in society, taking into account that this factor is a skill that is increasingly demanded by knowledge societies and by the so-called creativity capitalism (Bergua Amores, 2021).

3.3. Socio-cultural factors

The manner in which cultural and social values are expressed in the domestic environment or in educational institutions has the capacity to exert a significant influence on the potential development of creative thinking. This is due to the fact that such factors instil students with qualities such as flexibility, fluidity and innovation in their ideation, thereby engendering an environment in which novel ideas can be proposed without the apprehension of being interrogated or censured for their proposals.

4. Conclusions: Implications of the PISA Test Results for Colombia.

In consideration of the results of the Programme for International Student Assessment (PISA) test for Colombia, the following aspects are recognised as fundamental elements to enhance not only the results of the test in creative thinking, but also to have a significant impact on creative capitalism (Bergua Amores, 2021) and knowledge capitalism, in which we live and which in the coming years will be even more demanding on citizens. This is attributable to two interconnected dynamics. Firstly, the social and scientific problems to which we will be subjected are inherently dynamic. Secondly, the business dynamics that demand new skills and capacity for flexibility from individuals are also dynamic. It is for this reason that the following conditions are applicable not only to Colombia, but also to some of the countries in the region. This is because they share similar challenges insofar as globalisation affects us all in similar proportions.

In order to encourage creative thinking in the educational curriculum, it is necessary to consider the study plans associated with the contents and pedagogical strategies. Given that the study plans are still very much anchored to the logic of memorisation and excessive reproduction of knowledge, it is necessary to promote active methodologies that stimulate the generation of ideas and problem solving in a novel way, as well as the use of tools that stimulate different forms of thinking, such as visual thinking, tools for the materialisation of ideas through the development of prototypes, and other techniques that encourage creative thinking, critical thinking, future thinking, and so on.

It is widely acknowledged that educators play a pivotal role in the realm of educational transformation, given their instrumental position in the selection of methodologies, strategies, and pedagogical approaches that are employed within the classroom environment. Consequently, there is a compelling necessity to provide educators with the requisite training and professional development opportunities, with a focus on fostering creative thinking in both educators themselves and their students. This suggests the necessity of a more profound comprehension of the intricacies involved in cerebral function in relation to lateral thinking, convergent and divergent thinking, brain plasticity, flexibility and creative adaptability, as well as open-ended problem solving and project design.

The promotion of creative learning environments necessitates that classrooms function as laboratories for the cultivation of creativity. This suggests a necessity for a redesign of knowledge spaces that integrates characteristics such as fluidity, serenity, stimulation and integration. These characteristics are materialised in physical-perceptual (anthropometric, biomechanical, perceptual) and psycho-perceptual (lighting, noise, temperature and colour, amongst others) aspects. In this sense, the configuration of space can contribute significantly to the establishment of personal interactions and interrelationships, as described by the physician H. Osmond (in Hall, 2005). Osmond (in Hall, 2005) distinguished between two types of social spaces: the "sociofuge" and the "sociopathic". The former refers to environments that discourage personal interrelations, while the latter, the sociopathic, promotes interpersonal relationships, dialogue and co-creative actions. Both types of spaces contribute to the construction of meaningful educational experiences (Palencia, 2023).

The promotion of a culture of innovation and the development of creative thinking are not skills that develop independently (Carretero Pasin, 2021). For these skills to become latent and concrete in a society, it is necessary to create conditions for their existence. That is to say, a culture of creativity and innovation must be fostered, supported at all educational and social levels and scales (Vélez et al., 2012). The promotion of original ideas that emerge in collaborative spaces is

indispensable for the consolidation of innovation in society. The creation of strategies to engage parents, teachers, students and managers in the creative process is imperative for the transformation of the educational landscape. This transformation will have far-reaching implications for the culture of social and economic creativity in the country.

Finally, it is imperative that the Colombian system, and that of other Latin American countries, adapt to novel methods of measuring knowledge, not only in relation to creative thinking, but also to promote other types of thinking and new ways of evaluating and encouraging originality and the quality of the answers or solutions proposed.

The conditions delineated above, in conjunction with the specific actions to be implemented in the classroom, have the potential to engender a substantial transformation in the educational and social landscape of the nation. The following specific actions can be enumerated: The implementation of programmes aimed at fostering creative thinking, such as workshops and national/local initiatives dedicated to the promotion of science and creativity (Lozano-Monterrubio et al, 2024), is a crucial aspect for the advancement of human knowledge. The strengthening of areas pertaining to the arts and humanities, through an approach that acknowledges the significant creative developments that have shaped humanity, facilitates a comprehensive understanding of the diverse manifestations of creativity across various disciplines, including music, literature, theatre and the visual arts (Jösch Krotki, 2023). The promotion of creative reading and writing has been demonstrated to be beneficial in a number of ways. Firstly, it has been shown to broaden vocabulary, stimulate the imagination and allow individuals to identify manifestations of creativity. In addition, writing has been found to encourage original ways of expressing ideas. The use of educational technologies is also essential for materialising thoughts and imagination that reveal possible worlds or original solutions to everyday problems. Finally, the creation of collaborative networks is essential for forging links between educational institutions, companies, social organisations, among others, in order to share experiences (Pellegrini, 2022) and resources for the promotion of creative thinking.

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