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Creativity in Education: differences by performance, age and sex

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Abstract

Introduction. Creativity is a capacity that is related to divergent thinking and is fundamental in the changing society of the 21st century for training competent students who can function in society. There are several psychometric tests for measuring creativity, among which the Creative Intelligence Test (CREA) stands out, which is widely used in various age groups.

Method. A systematic review of the use of the CREA Test in education was carried out, examining in-depth 37 articles, which particularly focus on analysing the relationship between creativity and the three variables of academic performance, age and sex. How to enhance students' creativity was also analysed.

Results. Multiple discrepancies were found between creativity and performance. This is also the case with the relationship between age and creativity, as it was not possible to derive a conclusive result from the works contributed. Furthermore, analyses by sex showed that in most of the studies there were no significant differences in creative abilities between women and men.

Discussion and Conclusion. Positive teaching environments influence the development of creativity, as occurs with the increase in creativity measured after the various interventions applied in different settings and age groups. It is concluded that creativity is enhanced in educational environments where active student-centred methodologies that promote flexibility and fluency as well as originality are applied.

Keywords: creativity, CREA Test, academic performance, age, sex

Resumen

Introducción. La creatividad es una capacidad relacionada con el pensamiento divergente, fundamental en la cambiante sociedad del siglo XXI, para formar alumnos competentes que se desenvuelvan en la sociedad. Existen diversos test psicométricos para la medición de la creatividad, entre los que destaca el Test de Inteligencia Creativa (CREA), ampliamente utilizado en diversos grupos de edad.

Método. Se ha realizado así una revisión sistemática del uso del Test CREA en el ámbito educativo, examinando exhaustivamente 37 artículos, centrados particularmente en el análisis de la relación entre la creatividad y tres variables como son el rendimiento académico, la edad y el sexo. Por otro lado, se ha analizado también cómo potenciar la creatividad en los alumnos.

Resultados. Se han encontrado múltiples discrepancias entre la creatividad y el rendimiento. Lo mismo ocurre en el caso de la interrelación entre la edad y la creatividad, no pudiendo extraer un resultado determinante de los trabajos aportados. Por otro lado, los análisis por sexo mostraron que en la mayoría de los estudios no había diferencias significativas entre mujeres y hombres respecto a sus capacidades creativas.

Discusión y conclusiones. Los entornos positivos de enseñanza influyen en el desarrollo de la creatividad, como ocurre con el aumento de la creatividad medida tras las diversas intervenciones aplicadas en los distintos entornos y grupos de edad. Se concluye que la creatividad se ve potenciada en entornos educativos donde se apliquen metodologías activas centradas en el estudiante, en las que se promueven tanto la flexibilidad y la fluidez como la originalidad.

Palabras Clave: Creatividad, Test CREA, rendimiento, edad, sexo.

Introduction

The European Commission, in its communication entitled "Achieving the European Education Area by 2025", states that improving digital competences, as well as other transversal skills including creativity, is key to achieving a quality and innovative European Education Area. Creativity and innovation are essential resources for human beings and so are objectives to be developed in our societies, both inside and outside the field of education (Elisondo et al., 2013).

Conceptually, creativity is defined as the capacity to produce an original product or a new project based on the imagination (Cropley, 2003; Hu & Adey, 2002). Creativity is associated with decision making and the generation of new alternative ideas to produce useful solutions for problems (Lappas & Fessakis, 2014; Sarmiento, 2017; Zhou & George, 2001).

With regards to the importance of creativity in the school environment, Craft (2000) identifies it as a process that involves imagination, posing questions and play. However, while creativity is clearly necessary for the education of the 21st century, it is also an open and controversial field (Runco, 2014). There is a long way to go in the educational context as traditional school education tends towards partial development of our mental capacity as it principally favours development of the left cerebral hemisphere, which is related to convergent thinking (Barbarán Sánchez & Huguet Ruiz, 2013).

The complexity of the construct defined as creativity, along with the obstacles from the educational system, make it hard to reach a broad consensus about its scope, the limits of its definition and agreement on how to measure it. Therefore, uncertainty has emerged among researchers about how to measure creativity and the most appropriate indicators. Since the initial psychometric studies of Guilford (1962), who conceives of creativity or creative thinking as a capacity that can be developed or exercised if skills or personal attitudes and internal or external factors that facilitate creative activity are identified, a number of instruments for evaluating creativity and its different manifestations have been created, perfected and standardised up to the present day. Most of the instruments are aimed at evaluating creative capacities based on tasks and procedures that evaluate divergent thinking, such as the Torrance Tests of Creative Thinking or the Guilford Battery, which are widely used in psychological research (Humble et al., 2017) and which agree that formulating questions is the basic cognitive process for creativity. In this line of arguing, creativity is

defined as the capacity to formulate questions and solve problems divergently (Corbalán, 2008).

Although psychometric studies are the most developed ones in the field of creativity, Said-Metwaly et al. (2017) mention limitations connected to a lack of validity and the evaluation of individual aspects and they emphasise the importance of considering the variability of the profiles of creativity in different contexts, domains and developmental stages.

In this vein, the CREA creative intelligence test is a psychometric instrument for measuring creativity that evaluates creative intelligence in children, adolescents and adults based on the formulation of questions when faced with visual stimuli. The CREA Test is based on theories referring to the classical factors of creativity (divergent production, flexibility, fluidity and originality), lateral thinking and cognitive styles (Corbalán & Limiñana, 2010), which emphasise the value of processes of formulating problems. CREA does not evaluate specific achievements or accomplishments in particular fields, but rather is an indirect measure of creative capacities (Elisondo & Donolo, 2018), as the ability to formulate questions is an indicator of the openness and versatility of the cognitive schema that characterise creative people (Corbalán et al., 2003).

CREA (Corbalán et al., 2003) was developed jointly by researchers at the Universidad de Murcia (Spain) and the Universidad Nacional de Río Cuarto (Argentina). It is intended to evaluate creative potential, where each new question involves an unexpected relationship between the subject and the stimulus. There are no right questions but instead an endless number of possible questions; the instrument's potential here creates a cognitive context that is conducive for divergent thinking and creativity (Corbalán-Berná et al., 2014; Elisondo et al., 2018).

The CREA Test has been used in research with populations in Spain, Argentina and the USA (Clapham & King, 2010; Martínez-Zaragoza, 2003). Its coefficients of reliability have been found to be adequate and it displays evidence for its validity. Correlations have been found between measurements done using the Guilford Battery and the Torrance Test and the creative capacities measured with CREA (Clapham & King, 2010; López-Martínez & Navarro-Lozano, 2008). The advantage of the CREA procedure is that it is a single indicator and so is simpler and more economic than measurements of multiple factors such as the

Guilford Battery and the Torrance Test (Elisondo & Donolo, 2016, 2018). The psychometric properties of this instrument and its achievements in measuring creative capacities through the process of creating questions have been established (Corbalán et al., 2003).

In this way, the CREA Test offers an indirect measurement of creativity, which it uses as an indicator of people's capacity to formulate questions when faced with three visual stimuli (A, B and C): sheet A (from the age of 10), sheet B (from the age of 12) and sheet C (from the age of 6). Sheet A shows an old telephone while sheets B and C show strange or absurd situations. Test subjects have four minutes to write as many questions as they can about what the sheet shows.

This test has become extensively used in research into creativity at a variety of developmental stages, as described in current research with children (Antoñanzas-Laborda et al., 2015; Cárdenas-Avila et al., 2018; Donolo & Elisondo, 2007; Segundo Marcos et al., 2020), adolescents (Castañeda-Rey et al., 2017; Ramos-Moreno et al., 2017; Trigueros et al., 2020) and adults (Bogaert-García, 2017; Caballero-García et al., 2019; Elisondo et al., 2018).

In this context, the present work aims to carry out an exhaustive review of compiled literature on the use of the CREA Test in the field of education since its origin and to update the existing information and the practical applications of the test being studied. To achieve this aim, we will attempt to consider in greater depth the most discussed variables, as well as considering in greater depth the methodologies, foundations, didactic resources and learning environments required to improve creativity, as set out in the selected articles that carry out interventions with students to try to increase their creative intelligence.

Methodology

Research design

In specialist literature and previous articles, the CREA Test has been used to search for relationships between creativity and intelligence (Elisondo & Donolo, 2010; Gatica & Bizama, 2019), creativity and personality (Elisondo et al., 2009) and creativity and styles of thinking (Gutierrez-Braojos et al., 2013; Lamana-Selva & de la Peña, 2018; Limiñana et al., 2010b; López-Martínez & Martín-Brufau, 2010). However, what has been analysed most and has been most controversial is undoubtedly the relationship between creativity and academic performance (Caballero & Fernández, 2018; Cárdenas-Avila et al., 2018; Ramos-Moreno et

al., 2017). Likewise, the optimal age for being most creative has also been a matter of interest for researchers for some time (Monreal, 2000), as have differences by sex (Harris, 2004).

Consequently, this systematic qualitative review is intended to answer the main research question, namely, is there a relationship between creativity measured as creative intelligence (with the CREA Test) and performance in the educational field? It also considers the complementary questions of: are age and sex variables that influence creativity? And can students' creativity be fostered?

This work was done following the standards of the PRISMA declaration for systematic reviews (Liberati et al., 2009). The search was carried out considering all of the articles about the CREA Test from its creation in 2003 to the present day compiled in the databases shown in Table 1.

Table 1. *Principal databases consulted*

- APA PsycInfo
- CEPAL (Comisión Económica para América Latina y el Caribe [Economic Commission for Latin American and the Caribbean])
- Dialnet
- InDICEs CSIC (Información y Documentación de la Ciencia en España [Science Information and Documentation in Spain])
- MEDLINE
- ProQuest
  - *Coronavirus Research Database*
  - *Ebook Central*
  - *ERIC*
  - *Materials Science &Engineering Collection*
  - *ProQuest Central*
- Pubmed
- REDALYC (Red de Revistas Científicas de América Latina y el Caribe, España y Portugal [Network of Academic Journals of Latin America and the Caribbean, Spain and Portugal])
- ScIELO Citation Index
- Scopus
- WoS and Web of Science (JCR)

Process

Only academic articles in English and Spanish were selected resulting from the combination of the following search terms: ("CREA test" OR "test Crea") AND (creatividad OR creativity) AND (Corbalán OR Corbalan) AND (educat* OR educacion) in the title,

abstract or keywords. The search was focussed in this way and the terms associated with creativity, which is an inherently very broad and non-specific term, were filtered.

The following inclusion criteria were used for selecting documents:

a. Peer-reviewed articles, to ensure a rigorous process of selection.

b. Publications in Spanish or in English.

c. Empirical studies that use the CREA Test as a tool for evaluating the construct of creativity for groups from the different levels of education.

d. Studies that collect data about academic performance or age or sex. Also, studies in which educational interventions are carried out, using active methodologies or technological or manipulative resources with the aim of determining whether they help to improve creativity.

The exclusion criteria were:

a. Documents in any language other than those mentioned above.

b. Repeated articles, theoretical studies and reviews.

c. Scientific publications about groups in other community spaces and non-educational organisations (excluding the use of CREA in prisons, the workplace, camps, etc.) as well as individual case studies.

d. Studies that cover the psychometric properties of the test, standards of reliability or validity of the test, as it is an instrument whose validity as a psychological test has been proven.

Figure 1 shows the screening flow chart followed to select the documents that make up the final sample of the articles reviewed applying the criteria mentioned. In this way we moved from 308 initial results to 87 documents extracted from the total (applying inclusion criteria a, b and c), which were exhaustively analysed and manually reviewed, and from which 37 were selected (42.5 % of the bibliography reviewed) applying the remaining inclusion–exclusion criteria which complied with the proposed selection criteria. The interpretation of their results is shown in this work.

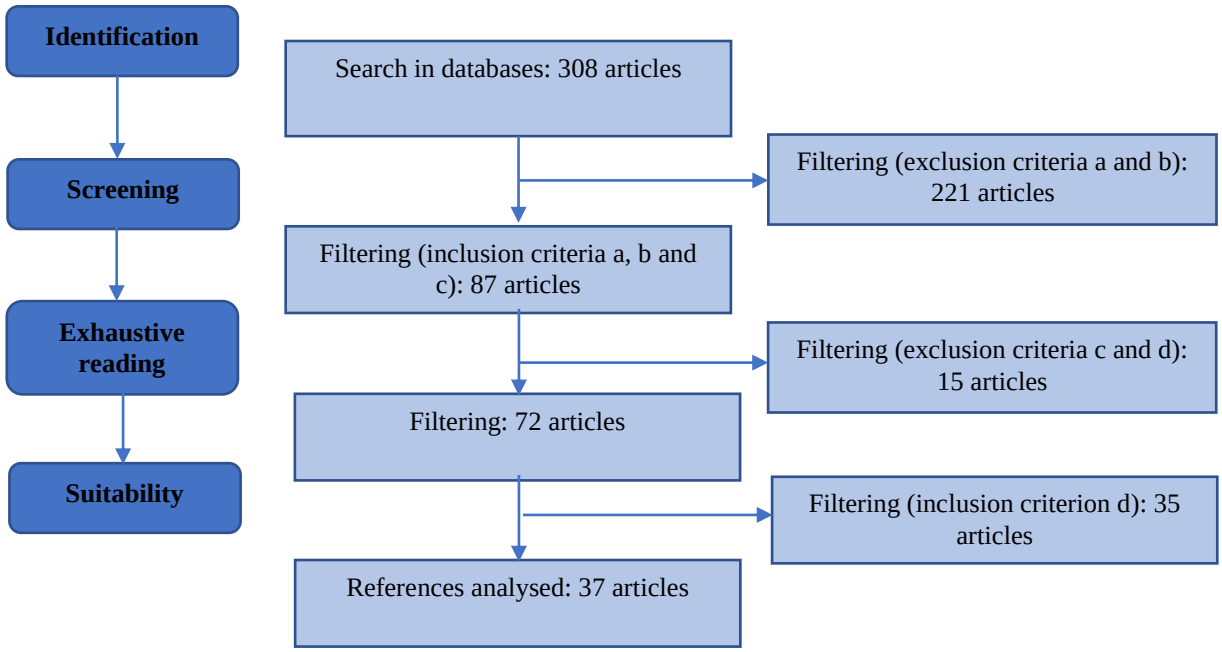

Figure 1. *Search and final selection of the references analysed*

Results

Table 2 sets out the main characteristics of the studies compiled in this systematic review.

Relations between creativity and performance

Of the 37 articles, 20 cover academic performance objectively with some type of test or evaluation in which a grade or qualification is obtained. The results regarding creativity analysed with the CREA creative intelligence test varied considerably. Five of the articles did not reach a firm conclusion regarding the correlation between performance and creativity (Antoñanzas-Laborda et al., 2015; Barrios et al., 2015; Mezcua-Hidalgo et al., 2019; Segundo Marcos et al., 2020; Trigueros et al., 2020).

Of the other 17, 6 found no statistically significant relationship between creativity and academic performance:

- Caldera Ortiz et al. (2018) and Cárdenas Avila et al. (2018) did not find one with primary-school pupils.

- No significant positive correlations between creativity and the academic performance variables obtained were found with older students, aged 15 and 16 (Ramos-Moreno et al.,

2017). This concurs with Lucero et al. (2017) in their study with adolescents aged 16 and 17 and Tunjo et al. (2017) with students aged from 12 to 14.

- At the university level, Hidalgo et al. (2018) found no differences between performance levels.

In contrast, there are studies in which creativity has a significant relationship with academic performance, such as the work of Barbachán Ruales et al. (2020) with university students, and the work of Lamana-Selva and de la Peña (2018) with year-4 primary school students, where the results reflect the existence of significant correlations between performance and creativity.

There are also several studies in which creativity influences learning, but it is only apparent in those cases where performance is high, as in the following studies:

- With university students in the works by Islas et al. (2019) and Lifante Gil (2014). In the research by Chiecher et al. (2018), with first-year students from engineering degrees, the best-performing students obtained higher average scores on the CREA Test compared to those with lower performance. In the study by Elisondo et al. (2018), engineering students who passed the modules had obtained significantly higher scores in creative capacities on the CREA Test.

- In secondary education, in the study by Limiñana et al. (2010a) with students aged 14–17, where the group with the highest achievements also displayed the highest mean grades. And in the work by Caballero and Fernández (2018) with students from year 4 of secondary education, where the students with the most creativity also displayed better performance in Spanish language, although not in mathematics.

-With students from year 3 of primary school, Martínez-Álvarez et al. (2020) found statistically significant differences in the mathematics competence variable when dividing the sample into two groups according to medium or low creativity.

Finally, two interventions (Casado & Checa, 2020; Checa-Romero & Pascual, 2018) reflect a significant increase in creativity, as well as a very positive evaluation in the end products generated by the students, who were considered to be highly creative.

Relations between creativity and sex

Of the 15 articles found that distinguish between sexes, significant differences in marks were not observed in the majority, independently of the students' ages.

- Caamaño-Navarrete et al. (2021), Donolo and Elisondo (2007), Klimenko (2010) and Parra et al. (2015) did not find significant differences in the scores of boys and girls at primary school. For their part, Antoñanzas-Laborda et al. (2015) noted that with children aged 4 and 5, girls' marks were slightly higher, although this was not statistically significant, both in the mean grade and in creativity.

- Mezcua-Hidalgo et al. (2019) and Sánchez Hernández et al. (2015) did not find significant differences by sex with secondary students.

- Almansa Martínez and López Martínez (2010), Chacón Araya and Moncada Jiménez (2006), Hidalgo et al. (2018), Limiñana Gras et al. (2010b), Rodríguez-Cano and Mendoza-Fuentes (2011), Vidaci et al. (2021) also did not find differences between the sexes with university students.

Only two studies found differences by gender:

- Caballero-García et al. (2019) with students aged from 18 to 43 found that women displayed more creativity than men, both before the intervention and after it, finding statistical significance.

- Chiecher et al. (2018) with 134 first-year university students on engineering courses also showed differences in favour of women.

Relations between creativity and age

There are 9 articles that look for a relationship between creativity and age and there are contradictions among their results:

- While Gatica and Bizama (2019), with primary school students aged between 6 and 8, observed a slightly higher development of creativity in older students, Klimenko (2010) and Parra et al. (2015) found in their work that age does not determine the level of creativity of children aged between 6 and 10.

- López-Fernández et al. (2018) found a significant positive correlation between age and creativity among the students aged between 10 and 16 that they analysed in their study. In contrast, Limiñana et al. (2010a) in a study with 15-year-olds did not find significant relations between creative performance and age.

- Finally, with university students, neither Almansa Martínez and López Martínez (2010) nor Limiñana Gras et al. (2010b) noted significant differences according to the subjects' ages, while Caballero-García et al. (2019) found that students aged under 20 display the most creativity, both before and after carrying out an intervention to increase creative intelligence. This was also the case with Chacón Araya and Moncada Jiménez (2006) in whose work creativity scores correlate significantly with age.

How to increase creativity

In all of the cases in which an intervention was carried out in the different fields analysed, the results obtained show an increase in creativity after applying the creative methodology, or with the use of technological or manipulative resources, independently of the age group represented:

- Klimenko (2010) carried out a workshop on cognitive and affective-motivational mediation teaching strategies in preschool over a period of five months.

- Barrios et al. (2015) applied teaching dynamics and materials to foster the acquisition and development of cognitive processes in a foreign language teaching module for 12 weeks.

- Tunjo et al. (2017) used active methodologies in natural sciences following an 8-hour intervention, applying two different strategies, the "check list" and "learning through curiosity".

- Checa-Romero and Pascual (2018) observed that creativity increased significantly after 8 weeks of an intervention in class with video games, specifically with the use of Minecraft.

- Caballero-García et al. (2019) executed a programme with an intervention of eight 90-minute sessions, with techniques such as "6 hats" and "Scamper" combined with activities that inspire positive emotions and emotional management when confronting the learning situation.

- Catarino et al. (2019) observed that the students who solved problems in cooperative groups obtained better scores in creative thinking than those who did so individually.

- Segundo Marcos et al. (2020) used a structured programme of reading and writing activities (7 weeks/12 sessions of 120 minutes) based on cooperative learning. However, it is true that the students did not display a corresponding improvement in grades.

- Casado and Checa (2020) found an increase in the creative capacity of primary students following the inclusion in class of STEAM and robotics projects as educational tools.

- Vidaci et al. (2021) applied a corporal expression programme with Sports Science students of 21 hours, over 7 weeks/sessions with good results, thanks to its content focussed on artistic–creative development.

- In addition, León et al. (2021) observed that use of an abacus to do arithmetic operations improved cognitive creativity skills, as well as improving concentration, attention and memory.

Table 2. *Characteristics of the studies analysed*

Authors	Year of the study	CREA Test sheet	Sample characteristics	Variables studied
Chacón Araya and Moncada Jiménez (2006)	-	-	75 Physical Education and Sports students from the Universidad de Costa Rica.	Sex
Donolo and Elisondo (2007)	2005	A and B for year six (aged 11), A and C for year four (aged 9) and year five (aged 10)	227 students from a private school in Río Cuarto (Argentina).	Sex
Almansa Martínez and López Martínez (2010)	2006–2007	-	1st year (35) and 3rd year (43) Nursing students, Universidad de Murcia.	Sex Age
Klimenko (2010)	2010	Pretest and post-test	80 Colombian children aged between 6 and 7.	Sex Age Intervention results.
Limiñana et al. (2010a)	2010	A and B	75 students from year 5 of secondary education at the European School of Alicante (equivalent to year 4 of ESO [compulsory secondary education] in Spain).	Performance (grades from the most representative subjects and the average grades for the semester). Age
Limiñana Gras et al. (2010b)	-	A and B	86 Speech Therapy and Psychology university students (aged between 17 and 46).	Sex Age

Rodríguez-Cano and Mendoza-Fuentes (2011)	2010	A and B	38 Fine Arts and Psychology students from the Universidad de Murcia (with a mean age of 22).	Sex
Lifante Gil (2014)	2006–2007 and 2010–2011	B pretest and A post-test	15–30 Chemical Engineering students from the Universidad de Valencia.	Performance (grades for the industrial design module).
Antoñanzas-Laborda et al. (2015)	2015	C	252 students (2nd and 3nd year of early years in schools in Zaragoza).	Performance (mean grade academic record). Sex
Barrios et al. (2015)	2011–2012	A pretest and B post-test	160 second-year students from the Primary Education degree at the Universidad de Málaga.	Performance (ad hoc tests to identify higher-order cognitive processes). Intervention results.
Parra et al. (2015)		-	788 students aged from 7 to 10 from public and private schools in Bucaramanga (Colombia).	Sex Age
Sánchez Hernández et al. (2015)	-	A and B	89 students from the 1st and 2nd year of ESO (compulsory secondary education) from public and state-funded independent schools in Murcia.	Sex
Lucero et al. (2017)	-	-	32 students aged 16–17 (11th grade) from the Dominican Republic.	Performance (evaluations by the teacher).
Ramos-Moreno et al. (2017)	2015–2016	A	51 students from year 4 of ESO (compulsory secondary education), Murcia.	Performance (grade from the first evaluation of the subjects).
Tunjo et al. (2017)	-	Pretest and post-test	86 students (12–14) from Colombia.	Performance (natural sciences subject). Intervention results.
Caballero and Fernández (2018)	2017–2018	-	59 students aged between 16 and 19, state-funded independent school in Madrid.	Performance (grades 2nd trimester in Spanish language and mathematics).

Caldera Ortiz et al. (2018)	2015–2016	C	66 students aged between 5 and 13 from a primary school in Encinasola (Huelva)	Performance (mean of all final grades obtained by each student for the different subjects during second trimester).
Cárdenas Avila et al. (2018)	-	-	85 students from years 4 and 5 of primary education from the Fundación Gustavo Aponte Rojas (Bogotá).	Performance (academic record of the students).
Checa-Romero and Pascual (2018)	2015	-	85 students from the first-year of secondary education, private school in Alcalá de Henares.	Intervention results. Performance (grade for the creative productions).
Chiecher et al. (2018)	2015	B	134 first-year university students on engineering programmes at a public university in Argentina.	Performance (high performance group and low performance group). Sex
Elisondo et al. (2018).	2015–2016	A	132 students from the Faculty of Engineering at the Universidad Nacional de Río Cuarto (Argentina).	Performance (number of modules passed after one and a half years and the general average obtained in the final exams).
Hidalgo et al. (2018)	-	B	100 students aged between 17 and 50 from 1st and 3rd year of the Social Work degree, Universitat de València.	Performance (mean baccalaureate grade divided into high and low performance). Sex
Lamana-Selva and de la Peña (2018)	-	-	91 students from year 4 of primary education, Madrid.	Performance (students' mean grade for mathematics in the second trimester).
López-Fernández et al. (2018)	-	C	65 Colombian students (aged between 10 and 16).	Age
Caballero-García et al. (2019)	-	A and B	206 degree and professional training students (aged between 18 and 43).	Sex Age Intervention results.
Catarino et al. (2019)	-	-	50 students from a Portuguese public university (aged between 18 and 35).	Intervention results.
Gatica and Bizama (2019)	-	C	65 Chilean students (aged between 6 and 8).	Age

Islas et al. (2019)	-	A and B	65 Computational Engineering students, public university (Mexico).	Performance (grades for the algorithms and data structure courses).
Mezcua-Hidalgo et al. (2019)	2016–2017	-	163 adolescents from years 1–4 of ESO (compulsory secondary education) from two secondary schools in Jaén.	Academic performance (mathematical calculations and linguistic reasoning speed). Sex
Barbachán Ruales et al. (2020)	-	A and B	43 students (aged between 16 and 26) of Mechanics in the Faculty of Technology at the Universidad Nacional de Educación (Peru).	Performance (mathematics, psychology, activities 1 and development courses).
Casado and Checa (2020)	-	A and C	57 students from years five and six of primary education, state-funded independent school in Móstoles.	Intervention results. Performance (grade for creative productions and for the exercise book).
Martínez-Álvarez et al. (2020)	2016–2017	C	82 students from year three of primary education, state-funded independent school in Ávila.	Performance (mean of the final grades obtained by the students on each of the subjects studied).
Segundo Marcos et al. (2020)	-	A pretest and C post-test	60 5th-year students from a primary school in Almería.	Performance (average grades for language and literature, mathematics, art, sciences, physical education and English). Intervention results.
Trigueros et al. (2020)	2018–2019	-	606 students (aged between 15 and 18).	Performance (grades obtained at the end of the academic year).
Caamaño-Navarrete et al. (2021)	-	-	248 Chilean students from a private school (aged between 11 and 12).	Sex.
León et al. (2021)	-	-	65 students aged between 7 and 11, Jaén.	Intervention results.
Vidaci et al. (2021)	2020	A and B	49 second-year students from Physical Activity and Licentiate degree in Sports Science at the Universidad de Alicante.	Sex Age Intervention results.

Discussion and Conclusions

Given that performance and creativity are two variables of interest that are continuously being researched, this work sets out to compile works centred on the use of the CREA Test to analyse the relationship between these two variables in a variety of educational contexts. The study is completed by comparing creativity with other variables such as the age and sex of the students surveyed and the execution of interventions that improve creative intelligence.

The conclusions endorse the complexity of the links between the variables analysed: creativity, age, sex and performance. So, multiple discrepancies were found when studying the correlation between creativity and performance. Positive correlations were observed in some cases (Barrachán, 2020; Lamana-Selva & de la Peña, 2018), negative ones were observed in others (Caldera Ortiz, 2018; Hidalgo et al., 2018) and the data were inconclusive in some (Segundo Marcos et al., 2020; Trigueros et al., 2020). This is also the case with the relationship between age and creativity, as it was not possible to derive a conclusive result from the works contributed. Moreover, the analyses by sex show that most of the studies found no significant differences between men and women with regards to their creative capacities.

Taking as a basis the heterogeneity and distribution of the works considered (in context, types of students, educational level, age, etc.) authors such as Chamorro-Premuzic and Furnham (2003) and Hutchinson (1963) argue that the relations between creativity and academic performance are complex, and so the discrepancies found might be the result of various causes. Among others, the subject area or module evaluated, the groups analysed or the educational style used. On the basis of the works complied, it is also theorised that most of the studies analyse samples with low significance, and so it cannot be concluded that the results are conclusive regarding the students' academic performance and their levels of creativity, or the relationship with other variables such as age and sex.

The most representative finding obtained through the review of teaching and learning methodologies based on the articles analysed is that the students who participated in educational interventions obtained significantly higher marks for creative intelligence at the

end of the process. This indicates that creative thinking, and divergent thinking skills in particular, can be improved through the use of active methodologies or manipulative resources.

The teaching–learning methodologies compiled in the review share the fact that they make it possible to foster processes of inquiry, discovery, rejection of rote learning, critical reflection, creation and imagination. It should be recalled that the CREA Test is based on factors such as divergent production, flexibility, fluidity and originality (Corbalán & Limiñana, 2010), which are the basis of the focus of most of the methodologies used in the interventions analysed.

The use of a didactic intervention seeks to create learning environments which, on the one hand, promote the activation of higher cognitive processes (Barrios, 2015), leading students to develop skills and competences to respond innovatively to the various problems they confront in the different areas compiled, and, on the other, they achieve benefits at a psychological level, which is useful for better academic achievements (Vidaci et al., 2021).

Empirical research has revealed the existence of different teaching practices, which have great potential to improve creative and innovative thinking, as well as the learning of different skills by students, which will be of use to them for solving problems. Among them there is the Design Thinking methodology for exploring improved decision making (Latorre-Cosculluela et al., 2020; Mosely et al., 2018), cooperative work to improve creative skills during the solving of complex problems (Catarino et al., 2019; Johnson et al., 2000), robotics and STEAM projects, which foster inventive thinking and creative problem solving (Casado & Checa, 2020; Zawieska & Duffy, 2015), gamification, which increases levels of motivation in students fostering creativity (Parra-González et al., 2021) and how the convergence of sciences, engineering, mathematics and art improves the creative skills needed for problem solving (Kim & Chae, 2016). De Bono (1988) already established that creativity can be acquired through practice, a mixture of attitudes and techniques. Specifically, through new procedures that make it possible to innovate and create new forms of action.

Therefore, what can be confirmed with the results analysed is that creativity influences learning and, in turn, positive learning environments favour the development of creativity, as happens when creativity is measured following the different interventions applied in the

different environments and age groups, independently of the area of work to which they belong.

Accordingly, new pathways for study and analysis open up in the field of neuropsychology to incorporate new study variables and to make students aware of their own creative process.

The need to design and apply intervention programmes focussed on both cognitive and emotional aspects to promote creativity and help with the integral development of the students is apparent (Chiecher et al. 2018; Martínez-Álvarez et al., 2020; Mezcua-Hidalgo et al., 2019). A number of authors underline the importance of carrying out activities to stimulate creativity, as it can be increased if it is adequately stimulated (Bermejo et al., 2014; Stevenson et al. 2014). We agree with Anastasiades (2017) that active participation by students in the construction of knowledge is necessary as an important prerequisite along with the very characteristics of creative thinking, such as imagination, originality and innovation. Sánchez Hernández et al. (2015) note that a more positive state of mind helps produce a higher score in the creativity test at a quantitative level. We cannot lose sight of the fact that creativity is a complex aptitude which encompasses not only cognitive processes but also emotional, personal and perceptive ones (Antoñanzas-Laborda et al., 2015).

Finally, as limitations of the study it is necessary to mention the use of scientific literature indexed in a specific number of databases. Looking to the future there is a need for continued enquiry in the search for relationships between the variables studied (creativity, performance, age and sex), as well as in other areas of use of the CREA Test such as the search for relationships between intelligence and personality or thinking styles and creativity, measured as creative intelligence.

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