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Article

Dimensions of creativity in secondary school high-ability students

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Abstract: Abstract: The objective of this article is to analyze the dimensions of creativity concerning students with high abilities. Firstly, a review of the most relevant scientific contributions on creativity is carried out. Next the dimensions of creativity in secondary school students who have been previously identified as high- ability students are analyzed. Those abilities associated to divergent thinking were assessed by means of the Torrance Test of Creative Thinking [1]. The fluency, flexibility and originality dimensions were assessed with the Scientific-Creative Thinking Test. The results obtained evidence that high-ability students achieve greater scores in both the figurative creativity and scientific-creativity dimensions. A significant relationship between creativity and high ability can therefore be established. This study is of an exploratory nature and the results obtained contribute to develop future studies in application of its findings in the teaching-learning process

Keywords: creativity; high ability; scientific creativity; secondary school students.

1. Introduction

To begin with, different most relevant scientific definitions and contributions related to creativity should be considered. In the early twentieth century, Wallas presented a description of the creative process by detailing four phases: preparation, incubation, illumination and verification [2]. In the 1950s Guilford carried out research on the nature and measurement of creative thinking capacities [3]. In the 1960s the work by Rhodes, defined four aspects, which influence creativity, known as the Four Ps (Person, Product, Process and Press) emphasizing the interrelation among person, process, product and environment for the creative production [4]. The topic of creativity has raised different conceptualizations, approaches and perspectives about this construct.

A first definition in this area is provided by Torrance 1965 who considers creativity as the process of identifying problems or data gaps, forming ideas from hypotheses, testing and modifying these hypotheses, and communicating the results [5]. This author considers creativity a general ability which is implemented in different domains. In other words, the creative person has general abilities that can be implemented in all areas. This implies a definition of creativity as the capacity of formulating, verifying and generating new ideas, assessing alternatives, looking for solutions, etc. Additionally, identified a number of dimensions of creativity which comprise: fluency regarding the number of answers [6]. Flexibility, understood as the capacity of changing the track of thought with regard to a particular task. Originality, referring to the answers of new and innovative nature. And elaboration, referring to all the additional details. Based on all these dimensions, this

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author elaborated an instrument that evaluates the capacity of people to produce different, original and alternatives ideas as a response to specific problems. By doing so the creative potential is intended to be assessed, considering both the qualitative and quantitative dimensions of divergent thinking. There is agreement that creativity is characterized by particular dimensions such as: fluency, figurative reasoning, divergent thinking problem solving and flexibility. Likewise, Renzulli establishes a relationship between high abilities and creativity. He considers high-ability people are more proactive in the search for new solutions and therefore are more creativity-oriented in their own processes with the aim of achieving a different, new and original result. This idea is closely linked with his claim that the creative capacity can arise under different circumstances [7]. Thus, this author considers both creativity and task self-motivation as behaviors related to high abilities. Similarly, Sternberg considers creativity to be an ability, which must be developed and practiced [8]. Kaufman and Beghetto developed a four- category creativity model, which help to unveil the different nuances among levels and types of creativity [9]. This model classifies a person according to creativity they have in every facet of life. A given person could fit into multiple areas.

More creative students tend to be more intelligent, adventurous, extroverted, and self-confident. They also have a less favorable attitude toward school. In terms of peer acceptance, sex appears to be a factor. Higher creative boys receive greater acceptance while higher creative girls are less accepted by their classmates [10], [11]. Other studies show that high creativity scores in both the figural and verbal area were associated with both high-test scores in English tests and high assessments in English. To a lesser extent high creativity scores were associated with high exam marks in mathematics and art. High creativity was associated with high verbal and quantitative IQ scores. Creativity increased with increasing age. Results suggest that although high levels of creativity may be associated with high levels of academic performance, this role is not a causative one. [12].

Hu and Adey consider that the creative thinking refers to the capacity to deal with problems in an original way. This implies a number of cognitive processes such as problem identification, analysis, search for hypotheses, reformulation, interpretation of results and experimentation, etc., from an integrated vision [13]. They consider creative imagination as a process whereby original and innovative solutions to problems are generated. They base this consideration on the use of previous experiences and on previous knowledge, as starting point to verify hypotheses and generate new solutions. They establish that creative thinking is related to scientific thinking, since both pursue the search for new concepts, as well as raising new questions which allow to solve the issues posed. It is understood that scientific thinking implies the cognitive processes applied to the specific actions of science, such as the generation of hypotheses, the use of causal reasoning and problem solving, etc. Scientific creativity is explained as the search for solutions to scientific problems. Through these cognitive processes, scientists pursue the achievement of an original result, worth scientific recognition [13]. This model is the origin of the Scientific-Creative Thinking Test which allows to research scientific creativity.

In 1965, Edwards and Tyler carried out an interesting research in which two creativity tests from the Torrance battery were administered to 181 9th-grade students along with the School and College Achievement Test (SCAT) and Sequential Tests of Educational Progress (STEP) batteries [14]. A high-SCAT group consisting of Ss scoring in the upper 3rd on SCAT but not on creativity was compared with a high-creativity group consisting of Ss scoring in the upper 3rd on creativity but not on SCAT. The high-SCAT group was superior on both school grade-point average and STEP scores. To test Torrance's threshold hypothesis, a twice talented group, high on both SCAT and creativity, was compared with the high-SCAT group. These two groups did not differ in STEP scores, but the twice

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talented group was significantly lower than the high-SCAT group on grade point average [14].

The results obtained previously in the exploration of scientific creativity suggest that high-ability students are more fluent than other students, (they generate a greater number of ideas for the problems or questions posed). On his part, Ruiz Melero found that higher-intelligence students also show better performances in most areas of scientific creativity and dimensions test (fluency, flexibility and originality) Previously, some authors reported a significant and positive relationship between intelligence and scientific creativity [15]. Along the same lines, the data found that scientific creativity complement with intelligence, academic performance and socioeconomic status [4].

Lastly, the contributions by Sternberg about the triarchic theory of intelligence are remarkable. Three types of intelligence are established: analytical, creative and practical. This author defines intelligence as a mental activity aimed at intentional adaptation, selection or transformation of real-world environments relevant to life itself, [8]. He considers the relevance for context adaptation to transform it, taking circumstances in account. In coherence with all this, this author considers creativity an ability, which can and must be developed, [4], [8].

In light of all this, the aim of this paper is to examine how to develop, enhance and nurture creativity. As pointed out by Perry creativity is type of learning process where teacher and pupil are within the same individual [16]. We think that the attention to the high-ability students in our country is far below what it should be. Therefore, these secondary school students do not receive the educational attention that would correspond to them. In this sense, the following statement should be highlighted "the need for special attention becomes more obvious when it is verified that different children who receive the same educational treatment, they do not always obtain the same results" [17]. Students with this high abilities and qualities require the educational support necessary to develop their talent. This study aims to make a first approach to this reality [18].

Stephen I. Pfeiffer studied creative high-ability students. The characteristics they show are great fluency of thought and a large number of ideas, to solve problems in an original and new way. Students who show these qualities and high abilities deserve the educational support develop their talent. This study aims to make a first approach to this reality [19]. This paper examines creativity with relation to compulsory secondary school high-ability students. This study in that educational center is exploratory in nature. It is carried out in adolescents aged between 12 and 16 since it is the age of education in our country. Based on this experience, it is intended to apply it to a larger sample in a near future.

Objectives

- To analyze creativity dimensions in high-ability students regarding fluency, flexibility, originality and elaboration (figurative creativity – Torrance Test of Creative Thinking Model TTCT, [20], trying to determine if there are differences in these dimensions between high-ability and non-high-ability students. From the research point of view, it is interesting to observe not only if there are differences in creativity between high-abilities and non high-abilities students, but in what specific dimensions of creativity such differences could be detected.
- To analyze the dimensions (fluency, flexibility and originality) of scientific creativity (Scientific-Creative Thinking Test model, TPCC - [9]-), trying to determine if there are differences in these dimensions between high-ability and non-high-ability students.

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In a sense similar to that of the previous objective, this test first allows us to identify if there are differences in any of these dimensions (fluency, flexibility and originality) between high-abilities and non high-abilities students.

2. Materials and Methods

This study has been carried out from a quantitative approach. This approach implies a cross-sectional study which allows to describe the study object at a precise moment without appreciating its evolution or antecedents. Therefore, an adequate approach is obtained to infer both qualitative and quantitative results.

Participants

At the start of the study, it was raised in 215 students and of them, 31 were identified as high-ability students, and the rest did not qualify for this category and thus were no high-ability students. In the application of the following tests, a difference can be observed in the N due to they were carried out during school hours on the established day and time, but due to several problems some students of the 215 were absent and therefore the data reflects that the N is composed of a smaller number of students. The sample is made from a compulsory secondary school in a Mediterranean city of 500,000 inhabitants. Students age range was between 12 and 16 years old with 50,3% male and 49,7% female. This range of age (12-16 years), corresponds to the compulsory secondary level education in this country.

High-ability students were identified following two procedures: that proposed by Professor Castelló y Battle and screening scales aimed at the detection of high creativity by Renzulli [21], [22]. Castelló y Batlle made a contribution for the researches of high abilities based on a study of the high ability, developed in a protocol for the identification of high-ability students, based on instruments of intellectual aptitudes and creativity [20]. This Castello y Batlle model emphasizes the existence of domains in which subjects can externalize greater skills. It is a model of study widely used in our country from its formulation [21].

Instruments

Two instruments were used, detailed as follows. These instruments were chosen because they were the best responded to the objectives of this research and allow the evaluation of creativity adjusted to the sociocultural context to the analyzed sample so that greater objectivity and reliability can be achieved in the evaluation and subsequent statistical analysis. On the other hand, they were known to evaluators and are easy to administer in an educational center context such as the pone used in this research:

1.Torrance Test of Creative Thinking (TTCT)

The Torrance Test of Creative Thinking was designed as an instrument to measure divergent thinking abilities [20]. The test comprises three games where student is asked to design a drawing, also to elaborate a story, and finally to trace several parallel lines from which to draw the maximum number of possible designs. The reliability obtained by the author was .90. A reliability of .78 has been obtained in the present study. We are interested in analyzing creativity in its different components, not considered as a unique ability, through the evaluation through the Torrance Test of Creative Thinking Model [20], which allows to differentiating scores in fluency, flexibility, originality and elaboration.

2. Scientific-creative Thinking Test Hu and Adey

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Based on Torrance Test it is an instrument to asses scientific creativity made by Hu and Adey which measures the fluency, flexibility and originality dimensions. Students are requested to detail all the scientific uses they would assign to a piece of glass. Also, regarding this request, they must ask scientific questions to ask questions and provide answers to others. The authors consider all areas ended up grouping together in a general factor of scientific creativity. With reference to the validity of the study, the factor analysis by Hu and Adey indicated that all items converge in a single factor which explains 63% of the variance [13].

In contrasting the results of both TTTC [20] and TPCC [9] tests, we could compare the results to detect possible differences between both tests and analyze which test would be more sensitive for detecting the different nuances of creativity in high-abilities students.

Procedures and data analysis

Tests were administered in the educational center during school hours, (from March to June 2019). They were corrected considering those protocols established by the authors themselves. Then the obtained data were treated using SPSS Statistic, version 24.0.

In the descriptive analysis of the variables, the minimum and maximum values, average, standard deviation and statistical frequency were reflected. Asymmetric rates and kurtosis were used to analyze the normality of the study variables. Likewise, the Kolmogorov-Smirnov test was used. Also, statistical tests were used to analyze the average difference between groups. In this light, parametric (Student´s t Test and ANOVA) or non-parametric test (chi-square and Mann-Whitney U Test) have been used according to the nature of variables. Likewise, the relationship between variables has been studied using Pearson correlation coefficient and Chi-square test.

3. Results

First, descriptive statistics were approached. Table 1 shows the minimum and maximum values, average and standard deviations, as well asymmetry and kurtosis scores and the values of the Kolmogorov-Smirnov test to establish data normality. It is found that three of the four variables of the TTCT test (fluency, flexibility and originality), do not fulfill the principle of normality since the significance value of test is greater than 0.05, which would indicate that these variables and dimensions (fluency, flexibility and originality) are manifested to a greater extent in the evaluated students and could be related in a more direct way to high abilities. [Table 1].

Table 1. Descriptive statistics for creativity dimensions measured for Torrance TTCT test [22] and TPCC test by Hu and Adey [13]. Source: own elaboration from data analysis of the SPSSS 20.0 program.

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	N	Min.	Max.	Average	SD	Asym.	Kurtosis	Kolmogorov-Smirnov		
								Value	Df[1]	P
TTCT.Fluency	211	1	40	21.21	8.20	0.11	-0.26	0.046	208	.200*
TTCT.Flexibility	211	1	40	19.88	8.12	0.21	-0.17	0.054	208	.200*
TTCT.Originality	211	1	87	33.74	16.34	0.41	-0.09	0.054	208	.200*
TTCT.Elaboration	211	4	126	38.30	19.70	0.94	1.54	0.075	208	0.006
HA. Fluency	212	10	90	35.50	13.67	0.86	0.87	0.087	208	P<0,001
HA. Flexibility	212	5	49	21.19	8.05	0.69	0.60	0.087	208	P<0,001
HA. Originality	212	8	139	39.93	20.18	1.17	2.49	0.094	208	P<0,001

*Lower limit of the true signification.
1 Degrees of freedom.

Secondly, to elaborate more on the previous results, descriptive statistics were found for each student group (high-ability vs. non high-ability). Figure 1 shows a graph of the average for both groups. In the graph, high-ability students obtain greater scores for all creativity dimensions, both in Torrance Test (TTCT), and in the scientific creativity test by Hu and Adey [13], [20].

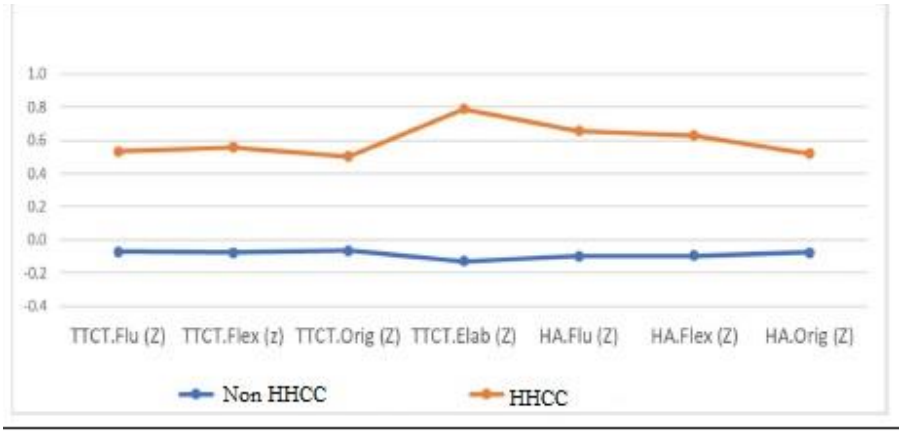

Figure 1. Graph of scores in the different dimensions of creativity for the high-ability and non high-ability students (Standardized mean scores (z) for creativity variables: Non HHCC n=177/178; HHCC n=31). Source: own elaboration from the data analysis of SPSSS 20.0 program.

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To verify if these differences were statistically significance, relevant pertinent statistical tests were performed. In the case of TTCT [20] variables, the Mann-Whitney U test was used, provided these variables are not distributed in a standard form, as we have analyzed in table 1. The test indicated significant differences ($p<.05$) for the four TTCT dimensions, always in favor of high-ability students [Table 2]. Once again, a creativity characterized by greater fluency, flexibility, originality and elaboration in high-ability students is related.

Table 2. Comparison of averages for Torrance Test of Creative Thinking [23]. own elaboration from the data analysis of SPSSS 20.0 program.

	Non-HHCC (n=177)			HHCC (n=31)			Comparison averages	
	Average	SD	Rank	Average	SD	Rank	U [1]	P[2]
TTCT. Flu	20.64	7.61	4.76	25.58	9.81	3.90	1981	0.014
TTCT. Flex	19.27	7.51	4.80	24.42	9.82	3.94	1979	0.013
TTCT. Orig	32.69	15.30	4.96	41.94	19.13	4.90	1991	0.015
TTCT.Elabo	35.76	17.70	4.47	53.81	23.56	5.53	1441.5	<0.001

(1) Mann-Whitney U Test; (2) Asymptotic Signification (bilateral)

In the case of dimensions measured by the TPCC test which assesses scientific creativity, the Student´s t test for independent samples was used, since variables are distributed in a standard form. The tests results showed that differences were statistically significant regarding dimensions of fluency, flexibility and originality, always to in favor of the high-ability students [Table 3].

Table 3. Comparison of averages for Hu & Adey test [8]. Source: own elaboration from the data analysis of the SPSSS 20.0 program.

	Non HHCC (n=178)			HHCC (n=31)			T-*Student*
	Average	SD	Rank	Average	SD	Rank	
HA. Fluency	34.16	13.20	80	44.48	13.13	49	$t(207)=-4.021$; $p<.001$
HA.Flexibility	20.43	7.56	44	26.26	9.13	37	$t(207)=-3.839$; $p<.001$
HA.Originality	38.41	19.47	131	50.39	21.63	89	$t(207)=-3.108$; $p=.002$

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4. Discussion

It was intended through this study to facilitate a better understanding of high abilities of secondary school students, in the age range between 12 and 16 years old. The study was also carried out to research deeply into the relationship between creativity and high ability, as well as to know how creative dimensions appear in more able students. Both creativity and intellectual giftedness are complex constructs, and it is often difficult to delimit them. Therefore, it should be no surprise that their assessment is also complex.

The dimensions of creativity connected to high-abilities students were intended to be researched with an exploratory nature in this study. More precisely, it was relevant to obtain a deeper understanding of how figurative creativity behaves (as measured by TTCT and by TPCC in the case of high-ability students). The results of this study indicate high-ability students obtain greater scores in terms of fluency, flexibility, originality and elaboration (figurative creative, (TTCT), and dimensions (fluency, flexibility and originality) of scientific-creativity (TPCC), [20], [27] [13]. Hence, we can establish a relationship between creativity and high abilities.

In the study by Belmonte-Lillo, no statistically-significant differences were found between high-ability and divergent thinking (TTCT) but were found in the elaboration dimension (in favor of cognitive high-ability groups [23], [28]. In our preliminary study, significant differences are shown in terms intelligence in favor of cognitive high-ability groups. Data show high abilities are linked to more possibilities of improving, perfecting or adding new elements to an initial idea [32]. This is the capacity of being creative and seems to be present in the high-ability students evaluated.

The results obtained in the exploration of the scientific creativity match those of other studies which suggests high-ability students have greater fluency than the rest of students [24]. They generate a greater number of ideas to the problems or questions raised. Likewise, Ruiz Melero found out students with a greater intelligence also show better performances in most areas of the scientific creativity test and dimensions (fluency, flexibility and originality) [15]. Previously, some authors pointed out a positive and significant relationship between intelligence and scientific creativity [16]. In the same vein, data found out scientific creativity complement with intelligence, academic performance and socioeconomic status [25].

It is necessary to place these results in context, provided the authors of scientific creativity test (TPCC) carried out a study comparing students according to how skillful they were in the sciences area. Significant differences were found out ($p \leqslant .01$), between low-and average-ability students, but no differences were found between average- and high-ability students (according to the instrument´s own scales), though the scores in scientific creativity by high-ability students, were greater those obtained by average-ability students. The authors concluded that creativity is a necessary condition for sciences, but not enough for the expression of the scientific creativity of secondary school students [20].

5. Conclusions

It will be important to have more instruments which take into account cognitive abilities, creative abilities (of a general and specific nature), performance in the teaching-learning process, the potential to achieve excellence, as well as the motivational aspects and the context where that potential is developed. The results obtained in this study indicate high-ability students show greater scores for the figurative creativity and scientific-creativity dimensions (fluency, flexibility and originality). All this allows to establish a significant relationship between creativity and high-ability students.

These results match those of previous studies where high-ability students contribute to a greater number of new ideas to a question or problem raised [15] [29].

The results obtained coincide with others studies in the idea that it is appropriate to combine several methods, test and trials to be able to evaluate high ability and creativity as complementary aspects [26]. It cannot be ignored that they are complex and difficult to identify constructs. The results obtained in our study also correspond, with slight deviations, to the real proportions of the investigation of Castelló y Batlle [21]. Regarding to our sample, 31 out of 215 students have been identified, which represents 14%. This percentage is in accordance with the prognosis of some authors such as Renzulli who offer comprehensive identifications models [22]. On the other hand, it contrasts with more restrictive models which estimate that only 5% of the population is high-ability [17].

From the point of view of psychoeducational intervention, it is proposed to take advantage of the creative potential of high-ability students to enrich the teaching-learning activities, enriching with these dimensions (fluency, flexibility and originality) the learnings based on problems, learning by project or cooperative learning. The contributions of this study in the teaching and learning process of high-ability students are clear [31], and they coincide with the contributions of the Gagne model. This model helps us to process the information and to understand the idea of information being processed or transformed as structures are elaborated and reworked [33]. Therefore, the largest number of high-ability students should be identified, to be able to offer the attention required in the enhancement of their talent and ability [17], [26]. This study confirms that it is necessary to identify more in order to better able to serve them [30] [31] [34]. The final aim will be to apply them to teaching-learning process.

We can point out future lines of research such as:

-The contrast of these results in a larger research sample.

-Contrast these results in other ages (younger boys and girls, young adults…) to determine the evolutionary dimensions of creativity and high abilities.

-The design of educational proposals which allow the improvement of the educational attention of the high-abilities and high-creativity students.

6. Limitations

Finally, to explain that this study has an exploratory nature the results obtained will help us to develop further studies which will contribute to delimit the relationships between creativity and high ability. We are aware that one of the limitations of the present study is the need to develop the operations of educational nature. We intend to continue researching in order to develop these educational actions.

Other limitations have been related to the size of the sample, which is reduced but sufficient considering that it is a first approach to the subject. Regarding to the experience of this first study, we intend to continue researching enlarging the sample. Also, the age of the sample, centered on the beginning of the adolescence with relative ease to not attend school and this has resulted in a limitation of the stability in delivering the tests to the students.

Finally, another limitation is in the difficulty in defining concepts, high ability and creativity. The complexity inherent in the relationship high ability and creativity, and define their complementarity motivate us to carry out soon a systematic review.

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