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## Validity of Instrument to measure Creative Learning<sup>1</sup>

### Validez de instrumento para medir el aprendizaje creativo

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#### Abstract

This paper introduces the validity and reliability of the instrument CREA, whose objective is to measure the creative learning of students pursuing undergraduate academic programs in the city of Cúcuta, Colombia. It follows a design of a descriptive study of multidimensional scales validation through a factorial analysis, construct validity and facial. The study population is 23564 students of undergraduate programs offered by universities from San José, Cúcuta; 595 students between 18 and 25 years old constituted the sample. A scale of 35 items was obtained. Factorial analysis showed dimensions of pedagogical praxis-oriented toward leadership, creative thinking, emotional satisfaction, independence, creative attitude, productivity, competences in leadership and motivation. Internal consistency was adequate (Cronbach's alpha 0.72 to 0.95), overall intraclass correlation coefficient of 0.967 (95 % CI, 0.933-0.984), average of differences in summation of items -1.3 (SD 8.5) and Kappa indices greater than 0.9, which shows high agreement among experts. It is concluded that CREA is a valid and reliable instrument for the context of Cucuta, Colombia.

**Keywords:** Creativity, capabilities, test validity, youth, reliability.

#### Resumen

El artículo presenta la validez y fiabilidad del instrumento CREA, cuyo objetivo es medir el aprendizaje creativo de estudiantes que cursan programas académicos

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de pregrado en el municipio de Cúcuta, Colombia. Sigue un diseño de estudio descriptivo de validación de escalas multidimensionales a través de análisis factorial, validez de constructo, y facial. La población estudio la constituyen 23564 estudiantes de programas de pregrado ofertados por universidades del municipio de San José de Cúcuta, constituida la muestra por 595 estudiantes con edades comprendidas entre 18 y 25 años. Se obtuvo una escala de 35 ítems. El análisis factorial arrojó dimensiones de práctica pedagógica orientada al liderazgo, pensamiento creativo, satisfacción emocional, independencia, actitud creativa, productividad, competencias en liderazgo, motivación; la consistencia interna fue adecuada (alfa de Cronbach 0,72-0,95), coeficiente de correlación intraclase global de 0,967 (IC del 95%, 0,933-0,984), promedio de diferencias en sumatoria de ítems -1,3 (DS: 8,5) e índices de Kappa superiores a 0,9, lo cual muestran un alto acuerdo entre expertos. Se concluye que CREA es un instrumento válido y confiable para el contexto Cúcuta, Colombia.

**Palabras clave:** creatividad, capacidades, validez de pruebas, juventud, fiabilidad.

## 1 Introduction

The relationship between creativity and learning is a topic that, despite being studied, requires clarity, taking into account the context and the continuous changes in science and technology demanded by the current society. It was traditionally assumed that creative people were intelligent people and, therefore, they were people that not only achieved skills, but also a high academic achievement in the learning's process of different sciences. Other approaches established that the existence of different grades of cognitive ability determines different levels of creativity, but independent of intelligence (Wallack & Koga 1965). Torrance (1976), starting from the criteria that intelligence and creativity are different constructs, postulates that when the intellectual coefficient is below a certain limit, creativity is also limited, while, when the intellectual coefficient is above certain limit ( $CI > 115$ ) creativity becomes a dimension which is independent of intelligence quotient.

On the other hand, hypotheses in psychology and the educational field led to the theory of multiple intelligences, in which certain theoretical approaches of Gardner (1983) postulated that constructs like creativity and intelligence are the same; Gardner (1999) proposed a reasoning around learning supported in the creativity as interactive perspective from multiple intelligences and in levels that take into account the person, the discipline and its surroundings emitting judgments about the validity and quality of both the individual and its products (Bermejo et al. 2010); approaches where the constructs creativity, learning and creative learning in the field of human interactions have evolved from the complexity as emerging element, becoming constructs that are transversal to the human being and the society. Cabrera & de la Herrán (2015) state that researches about education and auto education for the students' creativity should continue to broaden areas of

collective consciousness and answer to indicators in education and innovation, to the solution of the society's problems and the explosion of scientific knowledge from training processes of students.

This explosion of scientific knowledge that progresses by removing the error, requires changes in the mental structures, an education for the generation of scientific knowledge requires also changes in the curriculums of educational institutions, where science adheres to pedagogy, where intellectual knowledge and social skills are constituted in an educational goal, where educational institutions promote creativity and teach the knowledge through a reflexive answer that reorients its praxis linking the student not only as a passive person but as a person with potentialities, competencies and abilities to be exploited and associated to what was taught; in order to achieve this, students must be known, characterized and evaluated in all their potentialities.

According to the global creativity index of 2015 of the Martin Prosperity Institute (Dutta et al. 2015), among 139 nations of the planet Colombia is in the position 71, below Venezuela which is in the position 61 and very far from Ecuador in the 44; in technology it was in the position 89, but in talent in the 75. It got better in tolerance and innovation, but it still has big challenges in innovation if it wants to reduce the gap that persists with the economies of the first world.

This reflects the necessity to integrate objective and subjective perspectives, which allow understanding and evaluating the creative action of the student, as this could help government agencies to prioritize education policies in innovation from creative learning, revealing the need to combine the dimensions that are part of this. The measurement of students, professors and universities are important, as Parody (2015) says, since it gives information to parents and young people for the decision-making.

On the other hand creativity as a factor of quality of programs and institutions is an important element to evaluate, in terms of dimensions according to models like the multidimensional model of quality MIDE, which, despite of being questioned, links creativity indicators in performance (specific skills, critical reading), teaching, research (researchers, works, papers, patents), internationalization (coauthored), presence and attraction (Observatorio de la Universidad Colombiana 2015), as well as an element to identify perceptions and the value given by youth to creativity taking into account the context in which it studies.

This problem can be observed by elemental components making evident the underutilization of available spaces for creation, as well as the lack of an efficient articulated network of places for the development of science from the awakening of creativity in young people in the classroom, talented young people that are not involved in innovation processes, traditional pedagogical praxis that are not framed in a real development of skills or critical dialogic approaches, as part of an integrated educational system of science and technology which gives an answer to approaches involved in policies and regional and national development plans and of other factors that may or not be associated to phenomena and are associated with innovation, in order to, as Wasserman (2015) stated, the Ministry of Education,

accompany, embrace and promote good institutional initiatives.

Thus, the problem has considerations of social and educational order, of innovation, knowledge generation and internationalization, demanding an integral formulation in response to necessities around the development of creativity in young people. In this sense, Bermejo et al. (2010) argued that there are not many valid instruments measuring the creative potential of students, which turns the identification of outstanding boys and girls into a problem. To this end an instrument that involves analyzing creative learning in young people in the city of Cucuta was designed.

To validate the instrument CREA will give an answer to this problem since generic scales allow valuing attitudes of groups in general; specific scales instead allow analyzing a phenomenon, problem or other variables related to the young's creativity in and during the learning process. The use of different scales and questionnaires is useful to establish states, apply social policies, as well as the assignation of resources according to Vivant (2013).

## 2 Methodology

Research follows a descriptive study of validation of an instrument. Population under study is formed by 23.564 students of academic programs offered by universities in the village San José de Cucuta, Colombia. Selected the sample through a sampling by conglomerates, the sample is formed by 595 boys and girls between 18 and 25 years, students of differential calculus, differential equations and mechanic physic of the universities Francisco de Paula Santander, Universidad de Santander, Fundación de Estudios Superiores Comfanorte (FESC), Instituciones tecnológicas de Santander and Escuela Superior de Administración Pública.

The research seeks to measure the construct creative learning of students pursuing academic undergraduate programs in Cucuta, Colombia. *Creative learning* is understood here from the approach of Csikszentmihalyi (1996) as knowledge built with the active implication of the subject, from his planning to his internalization, characterized by the intrinsic motivation, being focused on the student, with an open character of the teaching process, perceived as a process that allows the assimilation, acquisition, transformation of the psychic life of the personality's behavior in the levels of inducer and executor regulation leading to the new creative solution of different problems of life (Sáenz & Larraz 2015).

A questionnaire of multidimensional character was designed (Oyekale et al. 2009, Vergel et al. 2015), it evaluates whether the wealth of agglomeration is distributed in a fair way, according to the participation in activities of research, and if this factor impacts their creativity positively. It follows a model of structural equations (Boomsma 2006) and model of discrete election following the methodology of disintegrated analysis by dimensions and indicators including the index of overall creativity (Florida et al. 2009); measurement based on the talent, technology and tolerance, which allows identifying variables that determine the incidence of mea-

suring the percentage of persons in the labor force of creative type, the ability to innovate, taking into account the registered patents in a specific place, the industry of high technology and the diversity; as well as the variables of talent's development and learning ecosystem, openness and trust. The disintegrated, probabilistic model considers the individual behavior instead of geographic zones as observation unity, selecting among possible alternatives the one that maximizes its utility starting from the idea that creative learning is generated in the process of individual choice-making. Following the work of Becker there are economic and temporal restrictions, choosing kinds of intelligence of the young people  $G$  and leisure time  $L$  that maximizes its utility taking into account that if they dedicate more hours of work  $t_w$  to increase their academic performance  $I$ , according to the level of creativity  $w$ , learning investment  $c_j$ , time to solve a problem and acquire more learning, it was formally established:

$$\max U(G, L) \text{ subject to } G = I + wt_w - c_j, \quad yL = T - t_w - t_j \quad (1)$$

The procedure followed for the construction of the scale was the proposed by Morales et al. (2003), following steps like: define the construct to be measured, write the candidate items, taking into account dimensions of the intelligence test, learning and creativity, determine the mode of answer and the number of additional solutions, prepare the correction key, prepare questions or additional instruments in anticipation of studies to evaluate the content validity (consulting experts, cognitive interview, focus group), obtain the refined list of items, analyze if they discriminate and if they can be considered indicators of the same feature, obtain data of a sample, check the general reliability of the scale, select the definitive items, check the validity; the procedure included the technique of factorial analysis and factorial confirmatory analysis with the purpose of getting a decrease of the dimensionality of the analyzed data and obtain a set of factors that facilitate the theoretical interpretations of the findings. The exploratory factorial analysis involved the following steps, according to Pardo & Ruiz (2002): verification of assumptions, analysis of the correlation matrix, analysis of the explained variance, obtaining of the factorial solution and, finally, factors interpretation. The factorial confirmatory analysis follows the procedure logic of SEM analyzing the covariance structure that compares the covariance matrix derived from the observed variables and the matrix of covariances reproduced by the model.

In the same way variables of undertaking, exploration, and innovation, used in the study Creative City Index (Landry & Hyams 2012), as well as attitudes of the creative individual, expressed by Sternberg (2006), activities as beliefs, techniques, final orientation of the product, environmental control and use of the senses of scale of Kumar et al. (1997) and components from the model of Ambiele as right skills, cognitive style, explicit and implicit knowledge to generate ideas, creative thinking either divergent thinking, brainstorming, synthetic or analog thinking, associative thinking, thinking of bisociation, lateral thinking, janusian thinking (Ang & Low 2000) and associated to public relations according to model Green (2010) information, incubation, integration and illustration.

The instrument involved a main factor associated to the satisfaction with produc-

tivity (5 items), a factor associated with independence (5 items); a third factor associated with motivation (5 items). The variable flexibility, a classical indicator in the pedagogical practice (Campbell et al. 1976), is incorporated in the factor creative thinking (8 items). Variables corresponding to dimensions of creative attitude are also used (2 items), measured on a scale of 5 points in Likert scale, according to the considered by the student about his level, if he is well below the group average, just below, in an average position or if he considers himself above the average or well above the average of the group in which he studies. It includes the cognitive variation of dimensions considered most important in his life by each person (Brown et al. 2004), measured on a scale of 5 points, from 1 (fully unsatisfied) to 5 (fully satisfied).

Productivity measured through the question about the dedication to problems, activities proposed in classroom, ability to focus on the solution of problems during a long time, no discouragement facing failure, the search of other alternatives to fulfill assigned activities.

Independence measured from the establishment of priorities to fulfill a task, undertake solutions in an individual way and face solutions with a work team in the classroom, to look for new ways to solve a problem or develop prototypes or simulators, select new ways and reject indications about how to solve a problem or task, to make evident the effort when facing impediments that hinder the correct solution of a task or problem.

Motivation from participation with initiative and to know how to search information for solving problems, establishing links with partners to identify sources of information, showing interest in knowing what other groups of students do in other places to wide his spectrum of information about a technical scientific topic.

In the subcategory creative thinking indicators of form are applied (Torrance 1976, Cramond et al. 2005) in the verbal and figurative component in which the boys and girls enunciate consequences to an improbable situation, uses, formulation of questions about an action in images where an ambiguous situation applied to the formation they are receiving (class of differential calculus, mechanical physics, differential equations) shows, it was analyzed according to the hypotheses approach, solutions and proposed methods of solution, figurative from figures, curves, functions, functions families, subjects had to design drawings, functions compositions, mosaics, from translations or rotations, to model described situations in the classroom through graphics; propose solutions through the design of prototypes or models that allow simulating the solution. The evaluation of production considered fluency criteria, flexibility, originality, and enrichment of ideas.

Flexibility immersed in creative thinking, measured from establishing different solutions to a problem, not assuming the proposed by the teacher as the only one; considering that teachers must be open to different solutions proposed by students even when they don't correspond to the teacher's plan; establishing new performances as young people, different to the model of their parents and teachers, but inside the established norms; selecting different ways to study, in correspondence with conditions and demands of activities, obtaining satisfactory results and se-

lecting several solutions to everyday life problems.

Indicators of creative attitude relate to the identification of other opinions to change the points of view on dissonant or opposite criteria from the conditions for the solution of a problem, the undertaking of actions that allow interacting with their partners in assessments and operations relate to the solution of a task or problem of experimental type; confusion with the disorder, understanding of what exists in front of the disorder, even if he/she has trouble reaching clear conclusions; the ability of working well in the mess, the ability to quickly reach clear conclusions and an understanding of what exists.

We used the control variables: gender, age, socioeconomic level, educational level (7 levels) (González 2008), satisfaction with his education taking into account the development of processes of creation (1-5). The variable satisfaction with emotional resources, through items related to role, self-esteem, recognition, autonomy and facing (Prieto et al. 2008, Martínez et al. 2015), wanted to measure the satisfaction by his capacity of taking decisions, face them and control consequences, his freedom to express opinions, the treatment received, his position and recognition in society and his satisfaction with himself.

The index of the goodness of fit of the model was evaluated through the test of Hosmer-Lemeshow (Hosmer & Lemeshow 2000), where values lower than 0,05 indicated a bad fit of the model. The effects of multi-collinearity, evaluated through coefficient factors of inflation of variance  $VIF > 10$  (Hair et al. 1999), conditioning index  $CI > 25$ , dimension with load higher than 0,50 (Belsley et al. 2004), making analysis of linear regressions following the Popper's logic (Popper 1965). According to Garson (2015), measurements of goodness of fit were used (Hu & Bentler 1999)  $\chi^2$  (lack of meaningfulness reflects good overall fit of data with the proposed relations), SRMR (values below 0,05), CFI (values higher than 0,95), TLI (higher than 0,95), RMSEA (lower than 0,05). An asymptotically free procedure of estimation (ADF) was used; multivariate normal distribution was not required.

Regarding the attitudes toward collaborative ways of participation, the indicator of Inglehart (1977) was used in his scale to measure values, reduced to 3 items; the interviewed was asked for the first and second objective in importance that should be assumed by the institution in the next ten years to improve the creative learning in academic programs and its quality, what do you believe are the institutional necessities to improve the students' creativity? What actions do you propose to revitalize teaching in the classroom? These questions search to link the youth with the decision making through the logic of consultation (Parés 2009). The weighting of each dimension and indicator, according to the method factorial analysis, grants initially the same weight to each of the dimensions.

Regarding qualitative variables, it's intended a global approximation to social situations through the instrument CREA with the purpose of exploring them, describe them (Bourguignon et al. 2013) from an epistemological approach of type historical- hermeneutical, narrative method, through the interpretation, which begins as a hypothesis to become a thesis (Beuchot 2009).

Through open questions, stories, expressed in the narrative, it is intended to identify perceptions of young people in the creativity category, to enrich it and give it a new meaning from their language and their daily life, expanding conceptions. It was talked with young people individually to listen their narrative, through items of a semi-structured interview, to favor the character of colloquial descriptions against technical descriptions (White & Epston 1993). For this dimension we made a first qualitative evaluation of the questionnaire, in which participants suppressed and incorporated items and drafting suggestions; in a second evaluation the new questionnaire is sent again, so they weigh the importance or value of the items in an ordinal scale of 5 grades, calculating the variance of each item and the global one. With the resulting instrument, a study of reliability was made for this scale in which internal consistency and the intra observer concordance was valued. For that, we selected interviews from the base of video recorded interviews with research purposes. An expert assessed these interviews twice with an interval of evaluation of two months (procedure test-retest).

A model was structured whose statistics considered for valuing the fit of the structural model were the adjusted goodness of fit index (AGFI) and the goodness of fit index (GFI), which measure the percentage of the matrix of variances and covariances explained by the different equations of the structural model. The statistic AGFI takes into account the number of liberty grades regarding the number of indicators intervening. The values of alternative statistics proposed by Hu & Bentler (1999) y Hair et al. (1999) normed fit index (NFI) and comparative fit index (CFI) are also shown, as well as the index of incremental fit of Bollen, which provides a measure of relative fit when comparing the chi-square of the estimated model and of a reference model in which all observable variables are correlated.

Statistical analysis of validation determines parameters of internal consistency of the test, index of kappa of weighted Cohen (index of simple concordance), the intraclass correlation coefficient (CCI) (according to qualitative or quantitative variables) to determine the reliability intra observer using SPSS 22 and AMOS. In addition, the Kolmogorov-Smirnov test was applied to check whether the values of the scale were adjusted to a normal distribution, the Student's *t*-test for comparison of means for paired data and method of Bland and Altman to descriptively analyze the intra observer concordance. All the contrasts of hypotheses were two-sided, for  $p < 0.05$ .

### 3 Results

Complete information about the evaluation of creative learning of 595 students of academic programs in engineering, business administration, and agricultural sciences was obtained. There were not significant differences according to the age ( $p = 0,393$ ), scholarship ( $p = 0,796$ ), with predominance of women among cases ( $p = 0,017$ ). Real applications, emotional satisfactions, pedagogical practice oriented to leadership, proposed problems, resources in the classroom are the



most mentioned aspects when it is asked about the five most influential in their satisfaction. Concerning the indicators of MIDE, students are not linked to research projects, only three students belong to research groups, they don't register products, there are two teachers with Ph.D.

Goodness of fit indices show results  $\chi^2=45,19$ ,  $DF = 0,43$ ,  $p$ -value  $> 0,02$ .  $TLI : 0,965$ ;  $CFI : 0,971$ ;  $SRMR = 0,027$ ;  $RMSEA : 0,023$ ;  $1,6 < VIF < 2,8$ ; with  $(R) = 19$ . Results show that there are not problems of multicollinearity; controlling bidirectional effects or influence of other variables, the associative participation is not revealed as the predictor of dependent variables; then, to participate in associations doesn't have statistically significant effects on creative learning, the measures of fit of the model reflect consistent results. In the application of the test of Hosmer-Lemeshow  $p$ -value  $= 0,887$ , implies that the observed gets adjusted to the expected, there is high proximity among real and theoretical values, after using the model and calculating predictions with it, it's right, considering it as a calibration.

The test of nonadditivity of Turkey confirmed the additivity of the scale ( $p > 0,05$ ), which presented an internal consistency of 0,89 in productivity, internal consistency of 0,95 in independence, 0,91 in motivation, 0,967 in flexibility, 0,87 in creative attitude; satisfaction with his/her social integration and satisfaction with his/her emotional resources, in the context, they showed a relevant effect in creative learning.

Consistency of measurement shows that the functional scale works in a similar way under different conditions, depending on the same instrument, on the time of application, on the one doing the measurement, on the subjects, on the interaction between these sources and on the random error. Internal consistency of the instrument shows that the items measure the same concept, in this case, creative learning; the Alpha of Cronbach of 0,93 shows that the scale is homogeneous. In the same way, when analyzing Alfa by element the items inside the scale are complementary to each other, the one-dimensional scale measures concept only. Alpha based on standardized elements 0,91, shows high homogeneity and reliability of the instrument, the covariation level of items between them and a number of items or parts forming the test.

The variance analysis shows a median of 7 and variance 3,2 for 595 elements, Fisher of 2,6,  $p$ -value  $= 0$  between elements, Turkey estimations of potency in which estimations must be done to find an additivity of 3,925. It can be said that reliability measures the error generated by an instrument when being unstable and applied in several occasions. The correlation coefficient of 0,89 shows temporary stability and consistency in answers of individuals. For the stability of the instrument, it is observed a coefficient of reproducibility  $CR=0.899$  and a Gutman scale close to Alpha of Cronbach showing loyalty and stability of instrument ( $\lambda$  0,937,0,890; 0,879; 0,861; 0,898, ... for 35 elements).

Convergent validity by latent factors productivity ( $\alpha = 0,76$ , validity  $= 0,72$ ), independence ( $\alpha = 0,9$ ; validity  $= 0,86$ ), motivation ( $\alpha = 0,86$ ; validity  $= 0,82$ ), creative attitude ( $\alpha = 0,86$ ; validity  $= 0,76$ ), emotional satisfaction ( $\alpha = 0,72$ ; va-

lidity= 0,55), creative thinking ( $\alpha = 0,86$ ; validity= 0,75), leadership competences ( $\alpha = 0,9$ ; validity= 0,86), praxis oriented to leadership ( $\alpha = 0,77$ ; validity= 0,7).

The minimum marginal reproducibility 0,912, the effect of reagents distributed with extreme modal value. The coefficient of scalability of 0,153 indicates non-cumulative scale, showing reproducibility of the instrument for decision making in the set of all items by factor. This shows that the instrument is stable, i.e., the same results are obtained when using the instrument in similar conditions at different times and it is feasible to generalize results. In the model of bidirectional combined effects, where the effects of people are random and the effects of measures are fixed, the coefficient of correlation shows itself superior to 0,67, Fisher= 90,097, p-value equal to 0, showing acceptable reliability for single measures and high for average measures. For equivalence, the goodness of fit test of the model of parallel shapes, chi-square of 45,6, variance 0,5; correlation 0,7523; reliability scale 0,898; reliability without bias 0,98, coefficients of correlations between classes type C using a definition of coherence.

The analysis of construct's validity determines each coefficient of agreement between evaluators with level according to evaluators 1 and 2, 1 and 4, Kappa= 0,9687, error 0,03,  $T = 14,5$ ,  $p = 0$ ; level of evaluators agreement 1 and 5, 2 and 3, 3 and 4, 4 and 5, 4 and 7 Kappa= 0,898, error 0,03,  $T = 12,8$ ,  $p = 0$ ; level of evaluators agreement 1 and 3, 3 and 5, 1 and 6, 1 and 7 Kappa=0,868, error 0,03,  $p = 0$ ; level of evaluators agreement 5 and 2, 5 and 6, 2 and 4, Kappa=0,837, error 0,04,  $p = 0$ ; level of evaluators agreement 6 and 4, 6 and 7, 2 and 6, 2 and 7 Kappa=0,98, error 0,04,  $p = 0$ ; level of evaluators agreement 5 and 7, 6 and 3 Kappa=0,968, error 0,01,  $p = 0$ ; level of evaluators agreement, 3 and 7 Kappa=0,98, error 0,02,  $p = 0$ . The value of Kappa is statistically significant different to zero (Cohen 1960) and taking into account valuation according to Landis & Koch (1977) its Kappa value (0,91) suggests that the scores of experts are very similar, existing a strong almost perfect agreement between them, it is, a very good strength of concordance. It is concluded that scale is valid. Factorial analysis showed seven dimensions, adequate internal consistency (Alfa of Cronbach 0,81-0,9), and average of the differences in the summation of items -1,6 (DS: 8,56, limits of agreement of Bland and Altman were -16,9 y 12,3).

Significant correlations were found among the different tests forming the instrument, which suggested the use of exploratory factorial analysis confirmed also by the sphericity test of Bartlett ( $\chi^2 = 1717,9$ ,  $gl = 34$ ,  $p = 0$ ), index of Kayser-Meyer-Olkin (KMO=0,879) for detection of underlying dimensions, and compare the factorial structure found with the study of Chaparro et al. (2006).

In application of subscales categories are associated in a hierarchical model  $8 \times 2$  with indicators of productivity, independence, motivation, creative attitude, emotional satisfaction, with subscale role, self-esteem, recognition, autonomy and facing; leadership competences, with subscale: leadership in relations, tasks, change, abilities, creative thinking with subscale: fluency, originality, flexibility, verbal content graphing, figurative content, pedagogical practice with subscale teamwork, writing, presentations, practices, construction of prototypes, generation of

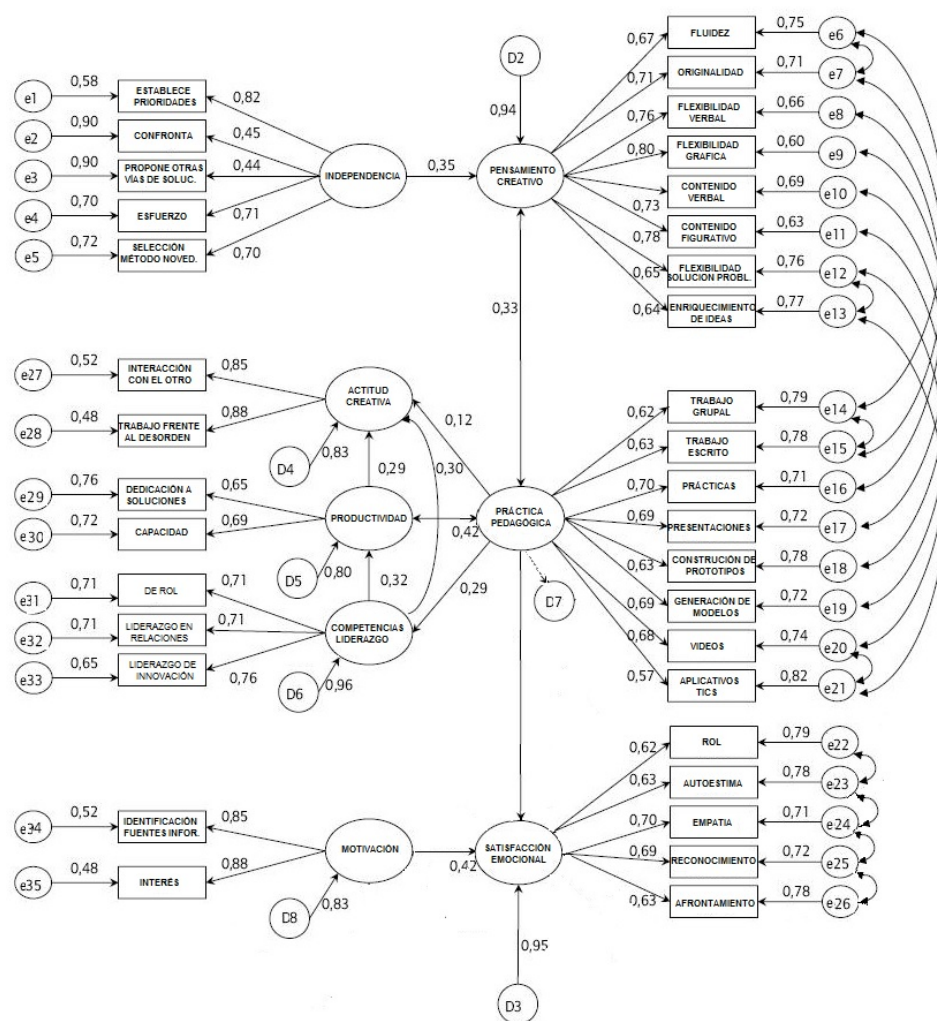


Figure 1: *Estimated Model. AMOS. Source: own elaboration.*

models, use of information technologies, generation of material as videos, blogs and the covariance of errors with the same content.

The structural model (figure 1) showed appropriate levels of fit (AGFI= 0,939, GFI= 0,95, Bollen's IFI=0,945, Qui= 971, df= 62,  $p < 0,001$ , CFI= 0,971, NFI= 0,973, RMSEA= 0,038), assuming itself as a way of analyzing the underlying structure to the performance of students against their creative learning in subtests. Total standardized effects of associative participation about Bca coefficient 95 % inferior, superior satisfaction with institution CI and pedagogical approach 0,04, satisfaction with activities promoting creativity 0,21, satisfaction with his/her so-

cial integration, satisfaction with his/her emotional resources 0,11; V of Cramer 0,16. The square root of the mean square error (RMS) makes evident that both the point estimate and the confidence interval confirm a high degree of fit to the data of the estimated model.

Results suggest an stable structure of eight factors for creative learning  $A_{ij}$ ; three factors of first order correlated: creative thinking ( $Pc$ ) main factor, pedagogical praxis oriented to leadership ( $\rho$ ), emotional satisfaction ( $Sc$ ); factors of second order: creative attitude ( $ac$ ), productivity ( $p$ ), independence ( $i$ ), leadership skills ( $cl$ ), motivations ( $M$ ) and 35  $X$  variables: fluency, originality, verbal flexibility, graphic flexibility, verbal contents, figurative content, solution of problems, enrichment of ideas, teamwork writer work, praxis, presentations, construction of prototypes, generation of models, videos, applicative uses, role, self-esteem, empathy, recognition, facing; priorities, confrontation, proposition, solutions, effort, selection of new methods; interaction with the other, work against disorder, dedication to solutions, capacity, of role, leadership of relations, leadership of innovation, identification of information sources, interest for creation. Found equations are:

$$A_{ij} = 0,9c_j + 0,95Se_j + 0,33\rho_j + 0,038 \quad (2)$$

Where

$$Pc_j = 0,35i_j + X_{2j} \quad (3)$$

$$Se_j = M_j + X_{3j} \quad (4)$$

$$\rho_j = 0,12ac_j + 0,29cl_j + 0,42p_j + X_{7j} + 0,3 + \sum_4^6 X_{7j} \quad (5)$$

Around facial validity, the suitability of content, according to Secolsky (1987), shows an instrument that fits with parameters of clarity ( $IC = 0,85$ ), precision ( $IC = 0,935$ ) and comprehension ( $IC = 0,937$ ). In this way each item fit the criteria of the category, is accurately written, easy to understand, to interpret and understand their meaning.

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## References

- Ang, S. & Low, S. (2000), 'Exploring the Dimensions of ad Creativity', *Psychology and Marketing* **17**(10), 835–854.
- Belsley, D., Kuh, E. & Welsch, R. (2004), *Regression diagnostic: Identifying influential data and sources of collinearity*, Hoboken, New Jersey: John Wiley.
- Bermejo, R., Hernández, D., Ferrando, M., Soto, G., Sainz, M. & Prieto, M. (2010), 'Creatividad, inteligencia sintética y alta habilidad', *Reifop* **13**(1).
- Beuchot, M. (2009), *Tratado de hermenéutica analógica. Hacia un nuevo modelo de interpretación.*, México: UNAM-Itaca.
- Boomsma, A. (2006), 'Reporting Analyses of covariance structures: Structural Equation modeling.', *A multidisciplinary journal* **7**(3), 461–483.
- Bourguignon, F., Ferreira, F. & Menéndez, M. (2013), Inequality of Opportunity in Brazil: A Corrigendum, Economics Papers from University Paris Dauphine 123456789/11396. Paris: Dauphine University. .
- Brown, J., Bowling, A. & Flynn, T., eds (2004), *Models of quality of life: A taxonomy, overview and systematic review of the literature.*, European Forum on Population Ageing Research., The address of the publisher.  
\*[http://www.shef.ac.uk/ageingresearch/pdf/qol\\_review\\_complete.pdf](http://www.shef.ac.uk/ageingresearch/pdf/qol_review_complete.pdf)
- Cabrera, J. & de la Herrán, A. (2015), 'Creatividad, complejidad y formación: un enfoque transdisciplinar', *Revista Complutense de Educación* **26**(3), 505–526.
- Campbell, A., Converse, P. & Rogers, W. (1976), *The quality of American life: perceptions, evaluations and satisfaction*, New York: Russell Sage.
- Chaparro, F., Ortiz, F. & Bruges, M. (2006), *Formulación de una estrategia de ciudad región del conocimiento para Bogotá. Una propuesta de acción.*, Bogotá: Universidad del Rosario. Departamento Administrativo de Planeación Distrital (DAPD).
- Cramond, B., Matthews-Morgan, J., Bandalos, D. & Zuo, L. (2005), 'Report on the 40-year follow up of the torrance tests of creative thinking: Alive and well in the new millennium', *Gifted Child Quarterly* **49**(4), 283–293.
- Csikszentmihalyi, M. (1996), *Creativity: Flow and the Psychology of discovery and invention*, New York: Harper Perennial.
- Dutta, S., Lanvin, B. & Wunsch-Vincent, S. (2015), *The Global Innovation Index 2015. Effective Innovation Policies for Development*, Cornell University, INSEAD, and WIPO.

- Florida, R., Balcells, R. & Arnau, A. (2009), *Les Ciutats creatives: com L'economia està convertint la tria de l'indret on viure en la decisió més important de la teva vida.*, Barcelona: Pòrtic.
- Gardner, H. (1983), *Frames of mind.*, New York: Basic Books.
- Gardner, H. (1999), *Mentes Creativas*, Barcelona: Paidós.
- Garson, G. (2015), *Structural Equation Modeling.*, Asheboro, NC: Statistical Associates Publishers.
- González, C. (2008), *El proceso creativo en el diseño arquitectónico. Encuentros Multidisciplinares*, Fundación General de la Universidad Autónoma de Madrid. Madrid, España.
- Green, A. (2010), *Creativity in public relations.*, London: Crest Publishing House.
- Hair, J., Anderson, R., Tatham, R. & Black, W. (1999), *Análisis Multivariante*, Madrid: Prentice Hall.
- Hosmer, D. & Lemeshow, S. (2000), 'A goodness-of-fit test for the multiple logistic regression model', *Communications in Statistics* **10**(1), 1043–1069.
- Hu, L. & Bentler, P. (1999), 'Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives.', *Structural Equation Modeling* **6**(1), 1–55.
- Inglehart, R. (1977), *The Silent Revolution, Changing values and Political Styles among Western Publics*, Princeton: Princeton University Press.
- Kumar, V., Kemmler, D. & Holman, E. (1997), 'The creativity styles questionnaire?Revised.', *Creativity Research Journal* **10**(1), 51–58.
- Landry, C. & Hyams, J. (2012), *The creative city index: Measuring the pulse of the city*, New Stroud: Gloucestershire/GB.
- Martínez, J., Vergel, M. & Zafra, S. (2015), *Comportamiento juvenil y competencias prosociales*, Bogotá: Ibáñez.
- Morales, P., Urosa, B. & Blanco, A. (2003), *Construcción de escalas de actitudes tipo Likert.*, Madrid: La Muralla.
- Oyekale, T., Okunmadewa, F., Omonona, B. & Oni, O. (2009), 'Fuzzy Set Approach to Multidimensional Poverty Decomposition in Rural Nigeria', *The IUP Journal of Agricultural Economics* **6**(3), 7–44.
- Pardo, A. & Ruiz, M. A. (2002), *SPSS 11. Guía para el análisis de datos*, Madrid: McGraw-Hill.
- Parody, G. (2015), *El ranking de las universidades: Miremos más allá del ombligo.*, El Tiempo, 23 de julio.

- Parés, M. (2009), *Introducción: participación y evaluación de la participación. En M. Parés (coord.). Participación y calidad democrática. Evaluando las nuevas formas de democracia participativa.*, Barcelona: Ariel.
- Popper, K. (1965), *The logic of scientific discovery.*, London: Harper Row.
- Prieto, M., Fernández, G., Rojo, F., Lardiés, R., Rodríguez, V., Ahmed, K. & Rojo, J. (2008), 'Factores sociodemográficos y de salud en el bienestar emocional como dominio de calidad de vida de las personas mayores en la comunidad de madrid, 2005.', *Revista Española de Salud Pública* **82**(3), 301–313.
- Secolsky, C. (1987), 'On the direct measurement of face validity: A comment on nevo.', *Journal of Educational Measurement* **24**(1), 82–83.
- Sternberg, R. (2006), 'The Nature of Creativity', *Creativity Research Journal* **18**(1), 87–98.
- Sáenz, D. & Larraz, N. (2015), 'El pensamiento creativo en la escuela'.
- Torrance, E. (1976), *Tests de Pensée Créative de E.P. Torrance: Manuel.*, París: Centre de Psychologie Appliquee.
- Vergel, M., Martínez, J. & Zafra, S. (2015), 'Validez de instrumento para medir la calidad de vida en la juventud: VIHDA', *Revista Logos Ciencia & Tecnología* **7**(1), 20–28.
- Vivant, E. (2013), 'Creatives in the city: Urban contradictions of the creative city', *City, Culture and Society* **4**(2), 57–63.
- Wallack, M. A. & Koga, N. (1965), *Modes of thinking in children*, New York: Holt, Rinehart y Winston.
- Wasserman, M. (2015), *Calidad de la educación. ¿Qué mide el Mide?*, El Tiempo, 24 de julio.
- White, M. & Epston, D. (1993), *Medios narrativos para fines terapéuticos.*, Barcelona: Paidós.