frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 19 July 2024
DOI 10.3389/feduc.2024.1387150

OPEN ACCESS

EDITED BY
Joana R. Casanova,
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Emporia State University, United States
Ssemwanga Ssonko,
Grand Canyon University, United States

*CORRESPONDENCE
Inés Alvarez-Icaza
✉ i.alvarezicaza@tec.mx

RECEIVED 16 February 2024
ACCEPTED 03 July 2024
PUBLISHED 19 July 2024

CITATION
Alvarez-Icaza I, Suárez-Brito P, Alvarez J and Molina-Espinosa JM (2024) Relevance of objective and subjective profile: creative behavior assessment in higher education students.
Front. Educ. 9:1387150.
doi: 10.3389/feduc.2024.1387150

Relevance of objective and subjective profile: creative behavior assessment in higher education students

Inés Alvarez-Icaza[1,2]*, Paloma Suárez-Brito[1], Jaime Alvarez[3] and José Martín Molina-Espinosa[1]

[1]Institute for the Future of Education, Tecnologico de Monterrey, Monterrey, Mexico, [2]School of Architecture, Art and Design, Tecnologico de Monterrey, Mexico City, Mexico, [3]Department of Design, School of Engineering, Takushoku University, Bunkyō, Japan

Creativity is a 21st Century skill. Promoting problem-solving and attending to global complex issues in formative learning experiences and professional endeavors is considered necessary. The assessment of creativity in higher education is a challenge itself due to few objective instruments for Spanish speakers and Latin populations considering this skill as key for current and future challenges. In addition to formal creativity training, which is based on curricula formed by a set of tools and processes, there is also the role of self-perception over this skill. The objective profile is the expected performance, while the subjective is seen as a self-declared ability. In this sense, having a proper assessment of creative behavior allows to align the intentions of institutions and educators toward an integrated professional profile in a multidisciplinary manner. In this study, the Creative Behavior Assessment Instrument was applied to pre-graduates from Creative Studies (CS; Design, Architecture, Digital Animation, and Communication) areas and other disciplines to answer three main research questions (1) Are CS students more creative than other discipline students?; (2) How does fluency vary between students from different disciplines?; (3) Is there coherence between the objective and subjective responses to the instrument? The methodological approach for this study is mixed methods, focusing on total score, visuospatial ability, fluidity, and self-perception. Results are discussed in terms of the difference shown by the students' objective/subjective profiles in relation to their discipline, the relevance of promoting creativity in higher education, and the implications of individual differences regarding the subjective profile.

KEYWORDS

creativity, creative behavior, creativity assessment, students, Creative Studies, higher education, 21st century skills

1 Introduction

Guilford's conception of creativity emphasizes divergent thinking as a key cognitive process leading to original and valuable outcomes. Divergent thinking involves four dimensions: fluency (quantity of responses), originality (going beyond commonly accepted ideas), flexibility (variety of responses), and elaboration (number and quality of details provided; Guilford, 1950, 1956, 1966, 1973). These dimensions provide a framework for understanding creative thought and action, suggesting that creativity emerges from the ability

to generate a variety of responses, to think originally, to shift between categories, and to elaborate on ideas (Weiss and Wilhelm, 2021). Guilford's model has been influential in the field of psychology and other disciplines, shaping the understanding of creativity as a cognitive process that is essential for producing novel and valuable outcomes. His work laid the foundation for subsequent research into the nature of creativity and its measurement (Jaarsveld et al., 2012). Currently, creative behavior is associated with diverse indicators referring to skills, attitudes, and capabilities that shape the workforce of the current production paradigm.

Creativity is also seen as a necessary skill for achieving effective solutions to complex global problems of the 21st Century, and it is incorporated into many formative educational experiences in the context of higher education. When combined with other relevant competencies, it contributes to a set of skills that are related to the current model of production and development (van Laar et al., 2017). Competencies of Industry 4.0 include a combination of skills and knowledge that allows a professional to do their job; the list is exhaustive (Hernandez-de-Menendez et al., 2020, 1,517), and it is aligned with the context of the current global challenges and the technical demands derived from them. In addition, studies have found a relationship between the presence of creative behavior and a proactive personality as a promoter of success in the work environment (Alikaj et al., 2021). It has also been highlighted that in order to achieve productivity and competitiveness, human talent is selected to match a general list of competencies, supported by intelligence and personality, and can provide social value to an individual and economic value to a company (Kipper et al., 2021). Very few studies have considered individual perception on their own performance, and the role it plays the 'objective competence profile' evaluation. Some of these studies refer to this perception on cognitive performance (Lam et al., 2011) levels of achievement (Carletto and Zezza, 2006) or the description of one's physical condition (Méndez-Giménez et al., 2020) or disease (Vicent-Gil et al., 2023). When this profile, or list of competences, relates to the knowledge, skills, and attitudes required according to a preset framework, it constitutes an "objective profile," as it sets the expected performance of an individual when a task is presented to be completed.

This study considers that for competences evaluation the "subjective profile," as a self-declared set of skills, knowledge, and behavior, plays a relevant role in the results of tasks fulfillment. This self-perception of our own capacities is shaped by a combination of experience, training, and development context (Arslan and Alanur, 2020). Conducting a self-evaluation of our competence profile allows us to retrieve key aspects of our practice, enabling us to recognize strengths and areas for improvement (Biencinto et al., 2021). In addition, the ability to assess our performance facilitates adaptation and improvement in meeting the demands of the work environment, while promoting the development of problem-solving strategies (Abdillah et al., 2023). These conditions are aligned with those required to develop the mega-competence of complex thinking and the sub-competence of innovative thinking (Ramírez-Montoya et al., 2024), based on creative behavior. Then, a "subjective competence profile" can be used as input for specific actions aimed at developing and scaling up the objective profile of a group or an individual.

Moreover, the comparison of these two profiles' evaluation can show relevant variations related to what is required for a professional position (Forsman et al., 2020). Having a proper assessment of creative behavior allows one to align the intentions of institutions and educators toward an integrated professional profile (Lensing and Friedhoff, 2018). Recognizing the importance of promoting sustained creative behavior within a company has been linked to improved outcomes regarding the organization's creative performance (Kim, 2020), which is a high-value indicator in our contemporary context. Hence, this study proposes to apply the Creative Behavior Assessment Instrument to pre-grads from Creative Studies (CS) area (first year of Design, Architecture, Digital Animation, and Communication pre-grad programs) and other disciplines to answer three main research questions: (1) How do creativity levels compare across students from different disciplines, including Computer Science?; (2) In what ways does fluency in idea generation manifest across students from various academic disciplines?; (3) To what extent do objective and subjective responses to the creativity assessment instrument align across different participant groups? The findings have a potential value to address development strategies for HiEd students, not only for CS areas but for every other discipline, since creative behavior is a transversal competency.

2 Materials and methods

The methodological approach followed in this study was mixed methods to consider the nature of creative behavior among undergraduate first-year students in the CS area of a Mexican private university. This research leverages quantitative and qualitative data to gain comprehensive insights (Åkerblad et al., 2021). Initially, the study employed a convenience sample of 53 students, comparing the results of creative disciplines students with students in other disciplines through the administration of the Creative Behavior Assessment Instrument (CBAI)®. The quantitative phase aims to provide objective, numerical data on the students' creative capabilities. While the objective profile cannot be directly assessed, a very accurate approximation can be achieved through the evaluation of visuospatial abilities, cognitive flexibility, problem-solving skills, and other cognitive processes related to this domain. These assessments provide insight into an individual's capacity to interpret and manipulate visual information, adapt to new or changing situations, and find effective solutions to challenges. By examining these cognitive functions, it is possible to gain a better understanding of the underlying qualities that contribute to the objective profile, allowing for a more informed approach to identifying and developing these traits.

The qualitative analysis delves deeper into the subjective profile, focusing on the type and quantity of answers in the fluency dimension, as well as the self-perception of the level of creativity through self-reporting. This qualitative data complements the quantitative profile by adding depth and context, allowing for a richer understanding of creative behavior that numbers alone cannot convey (McKim, 2017). The analysis represents an integration (Creswell et al., 2007) of data collected in both forms quantitative (number of answers) and qualitative (type of answers and self-report). The integration of quantitative and qualitative data in this mixed-methods approach provides a comprehensive understanding of creative behavior in undergraduate students.

2.1 Participants

Fifty-three university students (female gender 52.83%; male 45.28%; other 1.89%) between 18 and 30 years old (84.91% between

18 and 25 years old) participated in this study. Most of the sample reported being enrolled in a bachelor's degree program (94.34%) and the rest in a master's or doctoral program (3.77%) or another educational level (1.89%), belonging to private institutions (84.91%) and public ones (15.09%). Likewise, the majority (81.13%) reported being in the first phase of their educational program with 25% of credits completed, and the rest with 50% of credits or more. Regarding the area of knowledge, 45.28% belonged to the discipline of Creative Studies (including Design, Architecture, Digital Animation, and Communication) and the rest of the sample was made up of students from the areas of physical–mathematical sciences and engineering (3.77%), biological and health sciences (11.32%), social sciences and humanities (5.66%), engineering (3.77%), business (26.42%), biotechnology (1.89%), and information technologies (1.89%).

The presence of students from not only creative fields but also from sciences, humanities, engineering, business, biotechnology, and IT allows for a comprehensive examination of creativity across various domains of knowledge, assessing its expression and appreciation in technically oriented versus more traditionally creative disciplines. These characteristics make the sample well-suited for exploring educational, developmental, and cognitive research questions, particularly those that benefit from a multidisciplinary approach. This strategic choice enhances the study's ability to generalize findings across different student groups and educational contexts.

2.2 Instrument

The Creative Behavior Assessment Instrument (CBAI) consists of 10 items whose general objective is observing elements that constitute creative behavior in university adults 18 and older. It scores between 1 and 100 points, where 1 represents the lower degree of creativity and 100 the highest, and measures creative behavior per elements of fluency, novelty, flexibility, synthesis and analysis capacity, reorganization of objects, complexity, and evaluation ability, as Guilford (1950) proposed. In addition, it considers the following elements: innovation, problem-solving, language, visuospatial processes, mental rotation, logical reasoning, cognitive flexibility, and convergent and divergent thinking. In a previous study (Suárez et al., 2024), the validation process of the Creative Behavior Assessment Instrument (CBAI) consisted of two phases: construct validation and a pilot test. During the construct validation, the CBAI, featuring 10 items, was refined using the modified Delphi method, engaging experts from psychology, pedagogy, and education. These experts ranged in age from 26 to 60 and had professional experience up to 30 years.

In terms of validity, the instrument achieved a Content Validity Coefficient (CVC) for items between 0.930 and 0.999, and an overall CVC of 0.971, indicating excellent validity. The pilot test involved 386 Spanish-speaking participants predominantly from private educational institutions, with a majority aged 18 to 25 years. The reliability of the instrument was confirmed with a Spearman-Brown Prophecy coefficient of 0.870, showcasing high internal consistency. The beginning of the instrument has a section dedicated to a privacy notice and an informed consent form to guarantee the informed and voluntary participation of the respondents. Once accepted, the subjects answered six questions for their sociodemographic profile, providing data on the variables age, gender, institution, country, e-mail, and professional area.

The instructions for answering the instrument were: "Please answer each of the following sections individually." **The Creative Behavior Assessment Instrument is valid and highly reliable with a content validity coefficient of *CVC* =0.971 and a reliability coefficient of 0.870 for the Spearman-Brown Prophecy Formula statistic.** It is registered in the Public Registry of Copyright in Mexico City with Record number: 03–2023–060809274400-01 (López Caudana et al., 2024).

2.2.1 Scoring

The CBAI items include Likert-type, open-ended, and multiple-choice questions. Table 1 shows the CBAI items, their type, and maximum score.

Items 7 and 8 present images created specifically for this instrument. The image in item 7 presents two teal geometric bodies in the shape of an irregular hexahedron (RGB #008080) with a gradient effect, created with Microsoft Office 365 PowerPoint. The side-by-side configuration of the figures allows their comparison of identical physical characteristics but with possible perceived qualitative differences due to the gradient effect and the 180° rotation of one figure next to the other. The final size of the image used on computer equipment for item 7 is 12.35 × 32.99, with a resolution of 640 × 480; it maintains its proportion and color when presented on screens of mobile technological devices.

On the other hand, the figure used in item 8 is a maze with one entrance, two exits, and four possible routes for its resolution, digitally traced in two dimensions in black on a white background. It was designed using Microsoft Office 365 PowerPoint™.

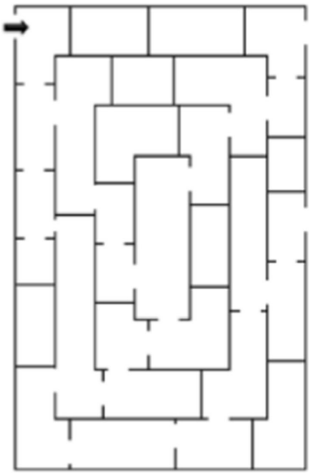
2.3 Procedure

Participants were first-year students from various areas of knowledge, all at the undergraduate level, contacted via invitations from two professors during the semester from June to December 2023. Professors played a crucial role in the recruitment process by identifying and inviting potential participants who they believed would provide meaningful insights into the study. This method of recruitment ensured that a diverse and relevant group of students was engaged, reflecting a wide range of disciplines and perspectives. Once accepted, the application took place in a single scheduled session. The students participated voluntarily in the study and were presented with a digital informed consent form. This document detailed the nature of the study, the procedures involved, the confidentiality of their responses, and their rights as participants, including the right to withdraw from the study at any point without any negative consequences.

After reading the consent form, students had the opportunity to ask questions or express any concerns they might have had. Once all queries were addressed, and the students felt comfortable proceeding, they digitally signed the consent form, thereby agreeing to participate. The session then moved on to the actual application of the instrument through the SurveyMonkey™ tool. Each professor was present throughout the session to provide instructions, answer any further questions, and assist with any difficulties the participants might encounter. Upon the completion of the instrument, the data were analyzed. During pre-processing empty or incomplete responses are

10.3389/feduc.2024.1387150

TABLE 1 Type and scoring of each CBAI item.

#	Item	Type	Score	Max score
Q1	¿Qué tan creativo te consideras? *[How creative do you consider yourself?]*	Likert	0 to 10	10
Q2	¿Qué tan fácil es para ti proponer soluciones a distintos tipos de problemas? *[How easy is it for you to propose solutions to different types of problems?]*	Likert	0 to10	10
Q3	¿Qué tan fácil es para ti pensar en más de una ruta para llegar a un lugar nuevo? *[How easy is it for you to think of more than one route to get to a new place?]*	Likert	0 to 10	10
Q4	Escribe todos los usos que se te ocurran para el siguiente objeto: Pelota. *[Write down all the uses you can think of for the following object: Ball.]*	Open-ended	1 point per given answer	10
Q5	Escribe todos los usos que se te ocurran para el siguiente objeto: Taza. *[Write down all the uses you can think of for the following object: Cup.]*	Open-ended	1 point per given answer	10
Q6	Escribe todos los títulos que se te ocurran para un cuento sobre un robot que tiene sentimientos. *[Write as many titles as you can think of for a story about a robot that has feelings.]*	Open-ended	1 point per given answer	10
Q7	Las imágenes que se presentan a continuación, ¿corresponden al mismo objeto? *[Do the images below correspond to the same object?]* 	Multiple choice	Answer — Score Yes* — 10 No — 5 I don't know — 1 *correct answer	10
Q8	¿Cuántas rutas existen para resolver el siguiente laberinto? *[How many routes are there to solve the following maze?]* 	Multiple choice	Answer — Score a) 4* — 10 b) 2 — 7 c) 3 — 5 d) 6 — 3 e) I don't know — 1 *correct answer	10
Q9	Resuelve el siguiente acertijo: Alex vive con Dany en un departamento antiguo. Un día Alex llegó después de hacer unas compras, saludó a un gato que miraba por la ventana del vecino, entró a su departamento y cerró la puerta. Después, dejó las llaves en la mesa y pensó: "Más tarde, cuando llegue Dany, le recordaré que mañana haremos reparaciones." En la noche notaron que la puerta estaba abierta. ¿Por qué estaba abierta la puerta? *[Solve the following puzzle: Alex lives in an old apartment with Dany. One day, Alex came home from shopping, said hello to a cat looking out the neighbor's window, entered his apartment, and locked the door. Afterward, he left the keys on the table and thought, "Later, when Dany arrives, I'll remind her that we are doing repairs tomorrow." In the evening, they noticed that the door was open. Why was the door open?]*	Multiple choice	Answer — Score a) The door opened on its own — 7 b) Alex did not close the door — 5 c) Dany left the door open* — 10 d) It was the cat — 3 e) None of the above — 1 *correct answer	10
Q10	Responde nuevamente la siguiente pregunta: ¿Qué tan creativo(a) te consideras? *[Please answer again the following question: How creative do you consider yourself?]*	Likert	0 to 10	10
			Total	100

identified and removed. Total and item scores were obtained for the total sample and by group according to discipline. Likewise, mean comparisons were performed with the student *t-test* for assessing differences between responses to items 1 and 10, and between groups.

3 Results

The results of the CBAI instrument obtained by the total sample will be presented differentiating the configuration of Objective and Subjective Profiles with respect to creative behavior, and subsequently, a comparison between the Creative Studies and Other disciplines groups will be shown.

3.1 General score

Regarding the total score obtained in the instrument, an average score of 64 points ($SD = 10$) out of a possible total of 100 was observed, with a range between 43 and 90 points. Figure 1 shows the distribution of frequencies with respect to this score, in which horizontal axis categorizes the scores into specific intervals that help in visualizing how the scores are distributed across different ranges. The vertical axis shows the number of participants that fall into each score interval. This axis is quantified with a maximum value of "$n = 20$," which means the highest number of participants in any given score range is 20.

3.2 Objective profile findings

To configure the Objective Profile, items 7 *Rotated images*, 8 *Maze*, and 9 *Puzzle* were considered, obtaining the following findings: for item 7 *Rotated images*, 75.47% answered correctly indicating that the images presented correspond to the same object, vs. 20.75% who answered "no"; and 3.77% answered "I do not know."

For item 8 *Maze,* only 11.32% responded correctly to the option of 4 possible routes to solve the maze. The rest of the responses were distributed among the options as shown in Table 2.

Likewise, for item 9 *Puzzle*, only 24.53% of the participants answered correctly. Table 3 shows the distribution of responses (in percentage and frequency) among the possible response options for the item.

3.3 Subjective profile findings

Questions 2, 3, 4, 5, 6, 1 and 10 were used to form the Subjective Profile. The results to item 2 *How easy is it for you to propose solutions to different types of problems?* showed an average of 7.4 points ($SD = 1.67$) out of a maximum possible total of 10, indicating that in general the participants reported ease in proposing solutions to different types of problems according to their self-perception. In question 3 *How easy is it for you to think of more than one route to get to a new place?* participants reported an intermediate ease with an average of 6.9 ($SD = 1.75$) points out of a possible total of 10, to think of more than one route to get to a new place.

Items 4 and 5 have been classified under the subjective profile because they measure fluency, but with an emphasis on its qualitative rather than quantitative nature. These items aim to assess the richness or diversity in the type of responses given. In assigning these items to the subjective profile, the need to verify the content of the responses was emphasized to ensure that participants did not include random or irrelevant text. This involved a review process in which each response was individually examined for its quality and its connection to the question, a task that inherently involves subjective judgment. To carry out this review effectively, a set of criteria was established to guide the evaluators in assessing the responses. These criteria focused on the coherence, and pertinence of each response, ensuring that it directly addressed the question and provided insightful or meaningful content. No responses were found that appeared random, out of context, or inconsistent, which speaks to the effectiveness of the initial data collection phase and the attentiveness of the participants. The authors of this study were the evaluators, ensuring a high level of familiarity and expertise with the subject matter being assessed. This level of analysis ensures that the fluency measures genuinely capture creative ability and not merely the capacity to produce meaningless text.

For fluency item 4 *Write down all the uses you can think of for the following object: Ball*, an average of 6.1 responses ($SD = 2.76$) out of a possible total of 10 was observed; and for fluency item 5 *Write down all the uses you can think of for the following object: Cup,* an average of 5.7 ($SD = 2.65$) responses out of a possible total of 10 was observed. Figure 2 shows two *word-clouds* with the frequency of occurrence of responses to items 4 and 5. A larger size of the written word represents a higher frequency of occurrence in the participants' responses. Most of the words were verbs like *play* and *drink* respectively, and nouns such as *football, circus,* and *coffee* appear less frequently.

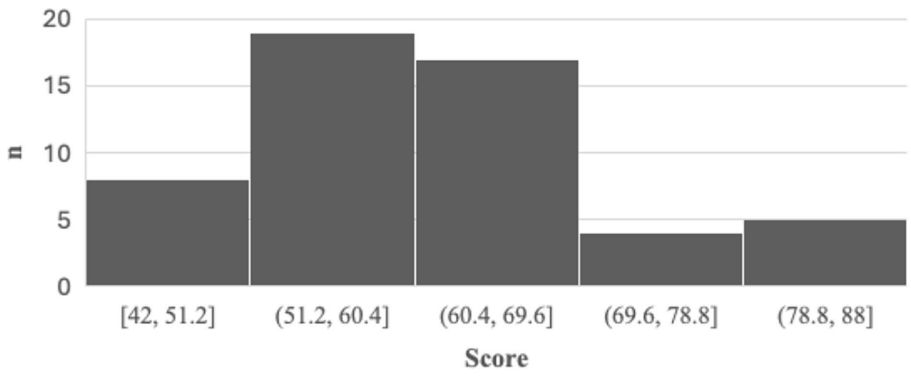


FIGURE 1
Frequency distribution of total score obtained by the participants in this study.

For fluency item 6 *Write as many titles as you can think of for a story about a robot that has feelings,* an average of 3.9 responses ($SD = 2.42$) out of a possible maximum of 10 was observed. A sentiment analysis was performed in which it was qualitatively observed that the titles proposed by the students used formal and correct language, but also included some elements of informal and creative language. The titles were mostly original both in Spanish and English, did not repeat each other much, and each participant expressed his or her own ideas and feelings. Most of the titles were positive in connotation, for example *Un robot con corazón* [*A robot with a heart*], *Sentimientos de hierro* [*Iron feelings*], and *Heart of steel*. Students expressed their enthusiasm for robots, curiosity about artificial intelligence, and belief that robots could feel emotions. In contrast, only one title with a negative connotation was observed, which expressed a feeling of sadness: *Circuitos tristes* [*Sad circuits*].

Quantitatively, the most frequent words were: *Robot* appearing 46 times, *Sentimientos [feelings]* 33 times, *Corazón [heart]* 23 times, *Amor [love]* 10 times, *Metal* 9 times, *No* 8 times, *Yo [I]* 8 times, *Sentía [felt]* 6 times, and *Robots* also 6 times. Some of the least frequent words, each appearing only once, include *Cop*, *Robosensible [sensitive robot], Botones [buttons], Más [more], Alla [over there], Llorar [cry], Senbot, Robosent,* and *Roboticos [robotics]*.

Finally, items 1 and 10 consist of the same question presented at the beginning and at the end of the CBAI to know the estimation of self-perceived creative behavior before answering the instrument, as well as to know the influence of the items on the estimation of self-perceived creative behavior at the end of the application. In these items, the results showed that, at the beginning of the test, participants reported an average of 7.1 points ($SD = 1.63$), and an average score of 6.3 ($SD = 1.66$) was observed at the end. This difference was statistically significant ($t = 4.50$, gl 51, $p < 0.001$) implying that students perceived themselves as less creative at the end of the instrument compared to the beginning, regardless of their discipline.

3.4 Differences between disciplines

To determine whether there are differences in creative behavior between different professional disciplines, comparisons were made of the scores of the Creative Studies vs. Other disciplines (physical–mathematical sciences and engineering, biological and health sciences, social sciences and humanities, engineering, business, biotechnology, and information technologies).

First, the differences between groups in the Objective Profile were analyzed and it was observed that the Other Disciplines group showed higher scores in items 7 *Rotation* and 8 *Maze*, indicating a greater ability to solve visuospatial problems. In contrast, the same group exhibited lower scores on item 9 Puzzle, suggesting a lower aptitude for tackling logic problems compared to the Creative Studies group.

In relation to the Subjective Profile, significant differences were evidenced between the groups such that the "Other Disciplines" group obtained higher scores on items 3, 4, 5 and 6, indicating better performance in terms of fluency compared to the Creative Studies group.

On the other hand, when examining the responses to items 1 and 10, which evaluate the subjective estimation of one's own creative behavior, it was observed that both groups perceived themselves as more creative at the beginning of the instrument (item 1) than at the end (item 10); this difference being statistically significant ($p < 0.05$ and $p < 0.01$). Comparing both groups, participants in Other Disciplines estimated self-perceived creative behavior to a lesser extent than participants in the Creative Studies group.

Figure 3 shows the results of each item for the total sample and for both groups, differentiating those of the Objective Profile and the Subjective Profile. The highest scores for each item are indicated with a yellow star icon, and lower scores with a gray star icon to facilitate comparison. Given that the Shapiro–Wilk results showed that the data from items 1 and 10 were not normally distributed (for de CS group: p-values of 0.003 and 0.030, respectively; for Other disciplines group: p-values of 0.297 and 0.073, respectively), intra- and inter-group mean comparisons are also presented, with Wilcoxon signed-rank tests for items 1 and 10 contrasts.

TABLE 2 Distribution of responses for item 8 Maze, of the CBAI.

Answer options	Score	Answers (%)	Frequency
4*	10/10	11.32%	6
2	7/10	43.40%	23
3	5/10	20.75%	11
6	3/10	11.32%	6
I do not know	1/10	13.21%	7

*Correct answer.

4 Discussion

First, this study focuses on understanding if Creative Studies students, i.e., first-year students of Design, Architecture, Digital Animation, and Media Communication programs are more creative than other discipline students. The answer will depend on the measurement approach, and in this study, it was observed that CS students perceive themselves as more creative than students from other disciplines. However, there were no statistically significant

TABLE 3 Distribution of responses for item 9 Puzzle, of the CBAI.

Answer options	Score	Answers (%)	Frequency
La puerta se abrió sola [*The door opened by itself*]	7/10	13.21%	7
Alex no cerró de hecho la puerta [*Alex did not close the door*]	5/10	28.30%	15
Dany dejó la puerta abierta* [*Dany left the door open*]	10/10	25.53%	13
Fue el gato [*It was the cat*]	3/10	18.87%	10
Ninguna de las anteriores [*None of the above*]	1/10	15.09%	8

*Correct answer.

	Item	Sample N=53	Arts & Design (n=24)	Other disciplines (n=29)	
Objective Profile	**7 (Rotation)**				
	Correct answer	75.47%	70.83%	79.31%	
	Incorrect	20.75%,	25%	17.24%,	
	I don't know	3.77%	4.17%	3.45%	
	8 (Maze)				
	Correct answer	11.32%	8.33%	13.79%	
	I don't know	13.21%	8.33%	17.24%	
	9 (Puzzle)				
	Correct answer	24.53%	29.17%	20.69%	
Subjective Profile	**2 (Solutions)**	7.4 *(SD=1.67)*	7.54 *(SD=1.09)*	7.28 *(SD=1.98)*	
	3 (Routes)	6.9 *(SD=1.75)*	6.88 *(SD=1.66)*	6.93 *(SD=1.76)*	
	4 Fluency (Uses *Ball*)	6.1 *(SD=2.76)*	5.79 *(SD=1.67)*	6.28 *(SD=3.33)*	
	5 Fluency (Uses *Cup*)	5.7 *(SD=2.65)*	5.13 *(SD=1.61)*	6.24 *(SD=3.14)*	
	6 Fluency (Titles)	3.9 *(SD=2.42)*	4.04 *(SD=2.37)*	4.45 *(SD=2.62)*	
	1 (How creative)	7.1 *(SD=1.63)*	7.46 *(SD=1.44)*	6.72 *(SD=1.66)*	t= 32.29, *gl 48*, p<.05*
	10 (How creative)	6.3 *(SD=1.66)*	6.54 *(SD=1.23)*	6.17 *(SD=1.89)*	t= 1.11, *gl 43*, p=.26
			t= 3.99, *gl 22*, p<.001*	t= 1.92, *gl 27*, p=.06	

**Significant differences*

FIGURE 2
Word clouds for fluency items 4 (left) and 5 (right). Larger words represent higher frequency.

differences between the groups when considering both the subjective and objective profiles at the end of answering the instrument, as shown in Figure 3. The tasks to be completed showed the ability of all participants to solve problems with creative behavior (Weiss and Wilhelm, 2021), without a specific influence of their background discipline. However, it is noteworthy that none of the groups ranked especially high and the mean of all participants was 64 out of 100 (Figure 1). The subjective profile then, this is their own perception of what they can achieve might play a role (Lam et al., 2011; Arslan and Alanur, 2020; Méndez-Giménez et al., 2020; Vicent-Gil et al., 2023) after the experience of being able to perform differently or better. Therefore, we can infer that creative behavior is not necessarily stimulated by the discipline of study, rather it is a set of skills that allow cognitive processes to connect resources as problem-solving abilities.

Second, regarding fluency variation between students' disciplines, might relate to their subjective profile, although it yields a quantitative measure (number of uses of a given object), the type and number of responses also play a role in estimating fluency according to Guilford (1950, 1956, 1966) pioneering work. For the work environment, a creative person would gather information from their surroundings in a variety of ways to propose innovative solutions (Hernandez-de-Menendez et al., 2020), then fluency allows to create more solutions according to the task. The results of the study showed that participants from Other Disciplines performed better than CS participants on all fluency items. The identification of such findings relies on the possibility of performing a modification in the curricula to foster the creative behavior and the proactive associated with it, in the line of what companies are looking for as core essential competencies in Industry 4.0.

Finally, this study found that responses to the instrument showed coherence between the objective and subjective profile. In general terms, those from Other Disciplines showed higher performance in the objective and subjective profiles for most of the items. However, the level of self-perceived creativity is much lower in other disciplines than in CS. This finding is of great relevance since the application of the instrument itself contributed to minimize these differences to the point of not presenting statistical significance. It can be said that the perception of CS students regarding their creative ability "adjusted" to a more "objective" estimate once they answered questions that, as a whole, account for the performance of a subject's creative behavior.

FIGURE 3
Scores for each item of the CBAI instrument, differentiated by Objective and Subjective Profiles, and by the groups of Creative Studies and Other disciplines. *Significant differences.

5 Conclusion

Promoting creativity in higher education is crucial for fostering innovation and adaptability in students, while recognizing and addressing individual differences in subjective aspects is essential for personalized and inclusive approaches to creativity development. In this study, we have made an approach to the evaluation of creativity in higher education; by the Creative Behavior Assessment Inventory (CBAI), we propose studying creativity as a cognitive process observable through specific behaviors. As observed, creative behavior does not depend on the disciplinary areas, although as there is enough relation between the self-perceived competence and the objective evaluation results, a fair consideration could be promoting the practice in students toward developing creative behavior. Based on the results, we suggest considering both objective performance aspects and subjective self-perception properties into any evaluation of creativity to achieve a more comprehensive understanding of this skill. Because of the above, it is crucial to question the reliability of perceived creativity levels collected through self-reports, as they may not reflect actual performance in this domain.

Creativity is a key competence in this century, and its proper assessment and encouragement are crucial for preparing students from any discipline for future and complex challenges. We propose using the CBAI as a valuable tool for assessing creative behavior and creativity as a desired skill. Future work to be developed is enlarging the sample and designing an intervention to improve the objective profile and to evaluate the correlation between the assessment of the objective profile.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical approval was not required for the studies involving humans because the instrument and its application were non-invasive in any sense and sensitive information was not collected. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

IA-I: Conceptualization, Formal analysis, Investigation, Supervision, Visualization, Writing – original draft, Writing – review & editing. PS-B: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. JA: Validation, Writing – review & editing. JM-E: Data curation, Investigation, Methodology, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. The authors would like to thank Tecnológico de Monterrey for the financial support provided through the 'Challenge-Based Research Funding Program 2023', Project ID #IJXT070-23EG99001, entitled 'Complex Thinking Education for All (CTE4A): A Digital Hub and School for Lifelong Learners'.

Acknowledgments

Academic support from Writing Lab, Institute for the Future of Education, Tecnologico de Monterrey, México.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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