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# Cultural Imaginaries and Complex Thinking: Impact of Cultural Education on the Development of Perceived Achievement of Complex Thinking in Undergraduates

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**Abstract:** This article presents the results of measuring the perceived achievement of complex thinking competency in a group of university students enrolled in a subject about Mexican cultural education. Specifically, the work intended to identify whether there is a correlation between the level of complex thinking and its sub-competencies with the appropriation of cultural knowledge. The sample population of university students from different disciplines took the subject "Imaginarios Culturales de México (Cultural Imaginaries of Mexico)". The descriptive methodology analyzed the means of the students' responses on a validated instrument measuring their perceived achievement of complex thinking competency and its sub-competencies. The questionnaire instrument was implemented at the beginning and end of the course without making a specific intervention. In conclusion, the research identified a statistically significant correlation between both variables, demonstrating that cultural training correlates with students' perceived achievement of complex thinking competency and its sub-competencies. These results contribute to both the educational theory associated with the development of formative tools of competencies and skills, as well as the revaluation of cultural appropriation as a relevant formative element in lifelong learning.

**Keywords:** professional education; educational innovation; complex thinking; critical thinking; cultural imaginaries; higher education



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## 1. Introduction

In today's society, higher education institutions are committed to providing their students with competencies that transcend their professional disciplines, fostering the development of transdisciplinary cognitive skills that contribute to their personal, social, and citizen development (Alfaro-Ponce et al. 2023; Silva Pacheco and Iturra Herrera 2021). For this reason, university curricula often emphasize increasingly important "soft skills", such as communication, teamwork, resilience, adaptability, empathy, leadership, problem solving, and complex thinking in the graduate profiles (Luna-Nemecio et al. 2020).

Thus, universities conceive the relevance of designing courses that, beyond a specific discipline, strive to develop the individual knowledge and skills associated with the social role of agents in a global environment (Tecnológico de Monterrey 2019b). In this sense, cultural training has represented the eagerness of institutions to delineate more comprehensive professional profiles, intending that their students understand, respect, and adopt the characteristics of their own and others' cultures as part of an interconnected and globalized world (Krebs 2020).

The course "Cultural Imaginaries of Mexico" pursues the goal of promoting reflection and analysis of the socio-historical, cultural, and art aspects of Mexico, recognizing the

dynamic conformation of identity and finding its interrelationships, thus developing in its participants a broad and reflective vision that allows them to understand and value the cultural heritage and the Mexican reality (Tecnológico de Monterrey 2019a). From a methodological approach, the course proposes the appropriation and developing knowledge of culture, art, and heritage, considering the complexity of the Latin American region due to its vast cultural richness and how it influences the identity of its citizens. However, can this course impact the students' development of competencies and cultural knowledge that is useful for comprehensive graduate profiles?

The purpose of this article is to present the results of measuring students' perceived achievement of complex thinking competency in a subject focused on Mexican cultural education. It will demonstrate a possible correlation between the level of cultural training and appropriation and the perception of achievement of complex thinking. With this objective, we seek to answer the research question: can cultural training influence the development of complex thinking? The selection of this competency is based on the way in which complex thinking contributes to the development of an integrated vision of the environment, both local and global, as a valuable transdisciplinary skill for any professional. The population was a group of university students from different disciplines and educational levels attending a technological university in Mexico, studying "Imaginarios Culturales de México (Cultural Imaginaries of Mexico)". The descriptive methodology analyzed the means of the students' responses on a validated instrument measuring their perceived achievement of complex thinking competency and its sub-competencies.

The present research relates to educational theory when searching for reliable and valid pedagogical tools for the development of formative competencies, but it is also relevant in terms of adopting a broader vision of the value of cultural training as a valuable pedagogical tool. This study has a direct impact on universities and educational institutions that seek to improve their competency training processes, as well as on any cultural entity that seeks to argue the relevance of artistic and cultural training in people. This research contributes to the educational theory of competency-based training.

The relevance of this study focuses on the constant need for educational institutions to find innovative tools that allow their students to develop more and better competencies and skills that are not only associated with the technical elements of their profession, but also with their lifelong learning. Specifically, this is a priority in the Latin American region, where traditional educational models focus on the acquisition of theoretical knowledge that ends up being obsolete in the face of constant changes in the environment. Furthermore, the needs of Industry 4.0 are still dragging on. Additionally, this is an especially interesting topic for Latin America, considering the vast cultural richness of its nations and the importance of cultural appropriation of its citizens in an increasingly globalized world.

### *1.1. Theoretical Framework*

#### 1.1.1. The Relevance of Cultural Education

Cultural, heritage, or artistic education or training refers to teaching the values, beliefs, customs, traditions, and ways of life of a particular culture or group (Cross 2013). Whether formal or non-formal, cultural education seeks to transmit knowledge and skills related to the historical past of a population, including art, literature, music, dance, gastronomy, beliefs, and any other element that is part of its heritage (Miller and Fuller 2006; Vega et al. 2015).

Therefore, training considering one's own or other people's cultural aspects helps to foster respect, understanding, intercultural communication, empathy, understanding, and valuing of diversity, as well as preserving and disseminating the heritage of a society (Manis 2012). By exploring culture and different perspectives of the world, students learn to appreciate the similarities and differences between themselves and the people around them, fostering empathy and understanding. In addition, recognizing the value of differences leads to understanding the relevance of collaboration, active listening, respecting opinions, and developing leadership skills (Holubnycha et al. 2021). In turn, cultural education

promotes creativity, allowing students to explore and express their ideas visually, verbally, or in writing, developing critical reasoning and innovative thinking that they can apply to decision making and problem solving (Boix Mansilla and Jackson 2022).

Thus, at the educational level, learning about culture, art, and heritage allows the development of transdisciplinary competencies and soft skills that help build comprehensive professional profiles that align with the globalized world's demands (Larson and Ngo 2017). Hence, it is increasingly common to find universities that, alongside their disciplinary programs, offer lines of cultural training, which include courses, subjects, and complementary workshops on art, comparative literature, music, philosophy, classical studies, cultural studies, and history, among others. Institutions such as Harvard, Cambridge, Oxford, Berkeley, Columbia, and Stanford offer their students multiple course options focused on elements of heritage and graduate programs with professional specialties in specific cultural aspects, programs with creative vision, historical analysis, or artistic appreciation (Wang et al. 2015).

Similarly, Latin American educational institutions increasingly consider the opportunities provided by cultural training, leveraging the region's vast heritage wealth to provide their students with complementary elements to their professionalization processes (Bayardo 2018). In this way, universities seek to contribute to the integral development of leaders and citizens committed to their environments with a critical and reflective vision of the Latin American social and cultural reality and its positive transformation. Additionally, they intend to promote the preservation of the region's heritage by allowing students to learn about and value their countries' artistic and cultural richness, fostering an inclusive, tolerant, and sustainable dialogue (Quintriqueo Millán et al. 2014).

#### 1.1.2. Complex Thinking Relationship with Cultural Imaginaries

Complex thinking is a cognitive skill that supports problem solving and efficient decision making through various types of analysis and reasoning (Tecnológico de Monterrey 2019b). This competency allows the decomposition of complex problems into their parts, which improves the ability to identify potential solutions and evaluate the advantages and disadvantages to determine the best action to take (Ramírez-Montoya et al. 2021).

Complex thinking is conceived as a macro-competency because it includes four associated sub-competencies: critical, systemic, scientific, and innovative (or creative) thinking (Vázquez-Parra et al. 2023). Critical thinking is a type of reasoning that facilitates the evaluation and validity of cognitive processes underpinning the generation of logical judgments regarding a situation or problem, deconstructing existing paradigms regarding current events (Cui et al. 2021). According to Jaaron and Backhouse (2018), systemic thinking involves analyzing problematic issues in a holistic and integrative manner, considering inter- and trans-disciplinarity. Systemic thinking interconnects reality, considering the complexity that reality possesses and the multiple and diverse elements that comprise it (Brown 2019). Scientific thinking uses problem solving based on objective methodologies with validated and standardized processes to research concrete evidence. This type of thinking allows individuals to solve problems from an integrated environment, which considers inductive and deductive cognitive processes for formulating and testing hypotheses (Suryansyah et al. 2021). Finally, creative or innovative thinking takes up the mental processes of search and discovery that, according to Zhou (Zhou 2021), facilitate contextualization and visualization from various angles and perspectives to trigger original and feasible solution proposals for the problems or challenges faced (Drucker 2021).

In today's uncertain, flexible, and changing society, these skills are essential for those who must adapt to the challenges of their environment, making this competency relevant in university training processes (Hiver et al. 2022). Complex thinking and its sub-competencies collectively allow individuals to combine knowledge, experiences, and practices to analyze information from multiple sources and identify patterns and relationships to generate new ideas and solutions (Cruz-Sandoval et al. 2023a).

Regarding the relationship between complex thinking and cultural and artistic training and teaching, it is vital to highlight culture's impact on how people think and process information, thereby influencing how individuals analyze and understand their environment (Meleady et al. 2021). In this sense, complex thinking implies the ability to analyze situations and problems from diverse perspectives, allowing one to consider multiple variables and how these interrelate, which can be strengthened by exposure to diverse cultures, perspectives, and ways of understanding the world (Manganelli et al. 2019).

Specifically, cultural training strengthens critical thinking by providing a solid foundation of knowledge, values, beliefs, and customs that influence people's perspectives, impacting how they analyze and evaluate information (Dubois-Shaik and Fusulier 2017). Cultural knowledge and recognition of one's own and others' heritage provide people with tools to understand and appreciate their reality from different approaches, questioning ingrained cultural assumptions and, thus, developing a critical view of the world around them (Halpern 2014).

Furthermore, culture influences how we relate to the world and its elements, emphasizing the importance of collaboration and the need to consider individual similarities and differences when making decisions (Shore 1996). Consequently, cultural education can be related to developing systemic thinking by contributing to the vision of diversity and social complexity, questioning the resolution of problems from a linear or reductionist approach (Cole and Packer 2019).

Overall, cultural training is essential in developing skills associated with complex thinking, which adds to the value other elements can have in the comprehensive training of future professionals (Ran et al. 2021).

## 2. Materials and Methods

The present research was based on a quantitative approach for the collection of data and analysis, as well as their systematization (Creswell and Creswell 2018) for the understanding of social phenomena. The descriptive statistical method was used for the description and subsequent correlation of data (Azen and Walker 2021). The objective of this study was to present the results of the perception of achievement of complex thinking competency among a group of students taking a subject on Mexican cultural education, seeking to identify the relationship between the level of complex thinking and its subcompetencies with the appropriation of cultural knowledge. Based on the above, the variables to be considered were as follows:

| | |
|---|---|
| Systemic Thinking | Critical Thinking |
| Scientific Thinking | Innovative Thinking |

Considering these variables, the development of this research relied on a statistical analysis, which included 2 phases:

First phase: specification of the sampling frame.

Second phase: comparison of scenarios:

1. General description of the pre-test study.
2. General description of the post-test study.

### *2.1. Participants and Procedure*

The application of the present study led to a sampling of 64 students with the following structure (Figure 1):

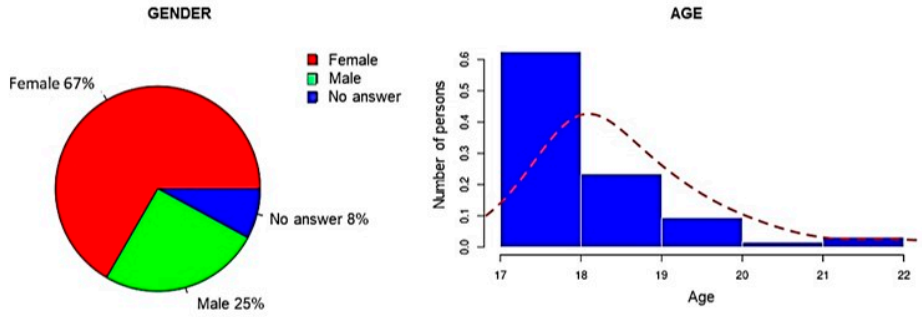


**Figure 1.** Sample frame of the participants (gender and age).

Figure 1 shows that the sample comprised 64 students of which 67% were female and 25% were male. More than 60% were aged 17 and the rest were 18 to 22. To respect each participant's personal information (except to identify and manage the information), acronyms for the students were used.

This sample comprised third to fifth semester students from a private technological university in the western region of Mexico who were taking a course on the cultural imaginaries of Mexico. This is a subject that is offered primarily to students of humanities and social sciences, although it is open to students from other disciplines. The course aims to promote reflection and analysis of Mexico's socio-historical, cultural, and art context. The study was carried out during the August–December 2022 semester.

It is recognized that the distribution by gender was not balanced; however, this balance might reflect the growing interest of women in courses focused on art and culture. Additionally, because it was an exploratory study involving people, the implementation was regulated and approved by the interdisciplinary research group R4C, with technical support from the writing lab of the Institute for the Future of Education at Tecnologico de Monterrey. The supervising committee suggested that the population be limited to a single group (class) of students, with the commitment to expand the sample if positive results warranted replicating the implementation.

### *2.2. Instrument and Data Analysis*

For this study, the E-Complexity instrument was applied, which was designed and validated by a group of experts (see Cruz-Sandoval et al. 2023b). The E-Complexity instrument measures the participants' perceived mastery of the reasoning for complexity competency and its sub-competencies. The means obtained for the criteria evaluated by the experts were clarity (3.31), coherence (3.38), and relevance (3.54). Based on the theoretical and content validation using expert judgment, the E-Complexity instrument was determined to be highly valid and reliable. The instrument consisted of 25 items grouped into 4 sub-competencies: systemic, scientific, critical, and innovative thinking. Its implementation was self-applied, and each item was scored on a Likert scale: 1: strongly disagree, 2: disagree, 3: neither agree nor disagree, 4: agree, 5: strongly agree.

The instrument was applied at the beginning and end of the course to measure the level of development of the perception of achievement of the competency and its sub-competencies based on the objectives of the course. This implies that no additional changes or interventions were proposed that could modify the course or its objectives to avoid any bias that could affect the collection of information. The present study seeks to assess whether the cultural appropriation promoted by the course in its current state could have an impact on the perception of the development of complex thinking.

Regarding data processing, a multivariate descriptive statistical analysis was carried out employing of RStudio computer software.

## 3. Results and Interpretation

In the pre-test scenario, Table 1 displays each sub-competency's general results for the mean, median, variance, standard deviation, and upper and lower limits. This table is

complemented by Figure 2, which shows box plots with the dynamics of the results, and Table 2, which presents the outliers.

**Table 1.** Dispersion and trend measures (pre-test).

| | Systemic | Scientific | Critical | Innovative |
|---|---|---|---|---|
| Mean | 4.180 | 3.627 | 4.096 | 3.966 |
| Median | 4.167 | 3.714 | 4.167 | 3.833 |
| Variance | 0.139 | 0.411 | 0.207 | 0.350 |
| Standard deviation | 0.373 | 0.641 | 0.455 | 0.592 |
| Upper limit | 5.000 | 4.857 | 5.000 | 5.000 |
| Lower limit | 3.167 | 1.429 | 2.500 | 2.333 |

Source: own elaboration.

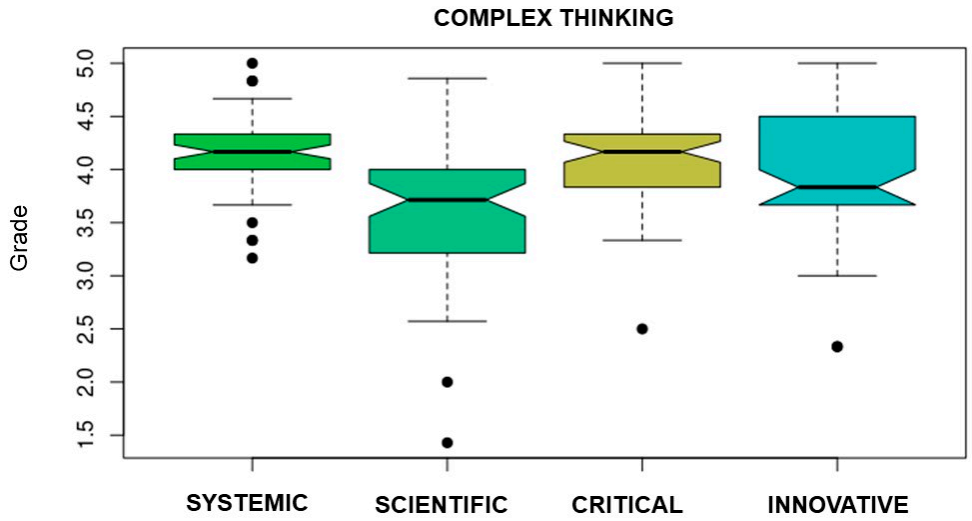


**Figure 2.** Complex thinking dynamics (pre-test).

**Table 2.** Outliers in the sample.

| | Systemic | Scientific | Critical | Innovative |
|---|---|---|---|---|
| Upper Limit | ACB, PLL, LBV, MAO, LOM, NDB; AAR, JADO, AXBH, DKG, MLRS, VRC, MGUF, DEGH, MFLH, JMCB y VMLK | None | None | None |
| Lower Limit | BJAE, JAVU, SCG, ALA, JAM y ALSE | JL, GMLC and QHR | JL and GMLC | JL, GLMC, QHR and FLLI |

Source: own elaboration.

In systemic thinking, the 64 students presented a mean of 4.18 with a lower limit below 3.6 (BJAE, JAVU, SCG, ALA, JAM, and ALSE). From the average score (4.18), the students ACB, PLL, LBV, MAO, LOM, NDB, AAR, JADO, AXBH, DKG, MLRS, VRC, MGUF, DEGH, MFLH, JMCB, and VMLK attained the upper boundary, exceeding 4.6. However, most of the students scored close to the median (4.16), which results in a narrowing (0.139 and 0.373) between the dispersion measures (variance and standard deviation) and the arithmetic mean, i.e., there is not a statistically significant difference among the systematic thinking of the students.

In scientific thinking, the mean was 3.627 and the lower limit was less than 2.5 (JL, GMLC, and QHR). Although there were students close to the maximum grade, they could not be considered outstanding (non-existence of the upper limit). Most students were below the median (3.714) where the dispersion measures (variance and standard deviation)

were far from the arithmetic mean (0.411 and 0.641), implying a more significant disparity in the students' scientific thinking.

Regarding critical thinking, the mean was 4.09. This sub-competency did not present outstanding students (upper limit); however, it had students with deficiencies with grades lower than 2.50 (JL and GMLC). The dispersion (variance and standard deviation) (0.207 and 0.455) from the arithmetic mean was slight, indicating that the students' critical thinking was similar.

Concerning innovative thinking, the average score was 3.966. It did not present outstanding students; however, its deficient students had lower scores (2.33) (JL, GLMC, QHR, and FLLI). Most students scored above the median (3.833), resulting in a variance of 0.350 and a standard deviation of 0.592. Despite the disparity between the dispersion measures and the arithmetic mean, the students' innovative thinking was deficient.

For the pre-test scenario, Table 3 analyzes the overall results of each sub-competency considering their mean, median, variance, standard deviation, and limits. This table is complemented by Figure 3, which shows box plots with the dynamics of the results, and Table 4, which presents the outliers.

**Table 3.** Trend and dispersion measures (post-test).

| | Systemic | Scientific | Critical | Innovative |
|---|---|---|---|---|
| Mean | 4.380 | 4.011 | 4.396 | 4.362 |
| Median | 4.500 | 4.000 | 4.417 | 4.286 |
| Variance | 0.193 | 0.306 | 0.153 | 0.124 |
| Standard deviation | 0.439 | 0.553 | 0.391 | 0.352 |
| Upper limit | 5.000 | 5.000 | 5.000 | 5.000 |
| Lower limit | 3.500 | 2.429 | 3.500 | 3.571 |

Source: own elaboration.

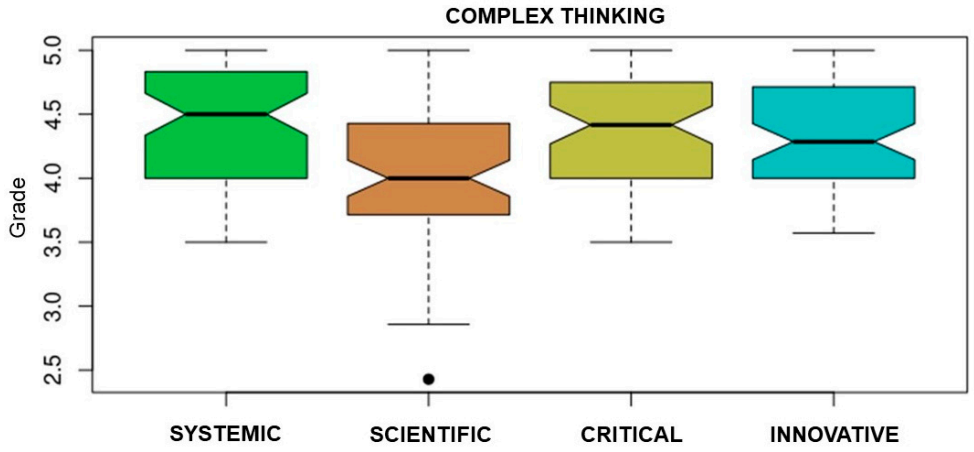


**Figure 3.** Complex thinking dynamics (post-test).

**Table 4.** Sample outliers.

| | Systemic | Scientific | Critical | Innovative |
|---|---|---|---|---|
| Upper Limit | None | None | None | None |
| Lower Limit | None | JL, GMLC y QHR | None | None |

Source: own elaboration.

Tables 3 and 4 and Figure 3 show the improvement in the four categories. In systemic thinking, the outliers disappeared; the 64 students obtained grades within normal behavior. However, in scientific thinking, students JL, GMLC, and QHR did not improve; therefore, another strategy to improve their learning is essential.

Regarding critical and innovative thinking, the data behavior is notable for no outliers in the sub-competencies of the sampled students.

When comparing the pre-and post-test scores, Figure 4 shows considerable improvement in complex thinking, and Tables 1 and 2 show the increase in the scores in each section of the sub-competencies.

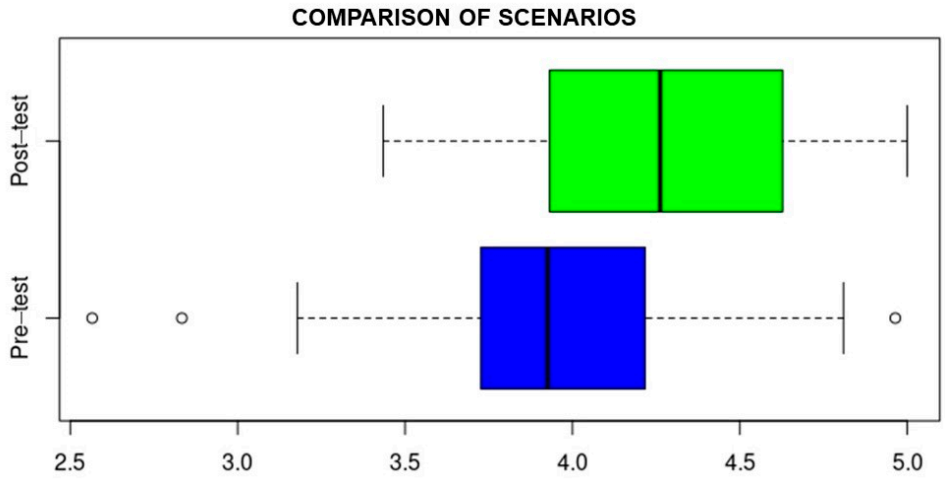


**Figure 4.** Comparison of pre-test and post-test scores.

In addition, Figure 4 illustrates the increase in the overall mean (from 3.925 to 4.262) in complex thinking.

Table 5 shows evidence of considerable scaling (improvement) between the before and after measurements of the cultural imaginaries course, since the correlation between the pre-test average and the post-test average [Cor(Pre-test, Post-test) = 0.5416] was high and positive, with a *p*-value (0.000) lower than 0.05 (t-student). There was sufficient proof of such benefits, with a high effect of 0.756 given by the d-Cohen's test.

**Table 5.** Pre-test and post-test correlation tests and effect tests.

| Correlation (Pre-Test Mean vs. Post-Test Mean) | Student's t-Test |
|---|---|
| Cor(Pre-test, Post-test) = 0.5416 | Welch Two Sample t-test<br>data: Pre-test and Post-test<br>t = −4.2942, df = 124.52, *p*-value = $3.494 \times 10^{-5}$ |
| Cohen's d. d estimate: 0.7564573 (medium), 95 percent confidence interval: | |
| lower | upper |
| 0.4878468 | 1.0250678 |

Source: own elaboration.

To complement this information specifically by participants, Figures 5 and 6 show the students' improvement in the elements comprising complex thinking, that is, the achievements and limitations of each participant. These results open the possibility of subsequent interventions, although specifically.

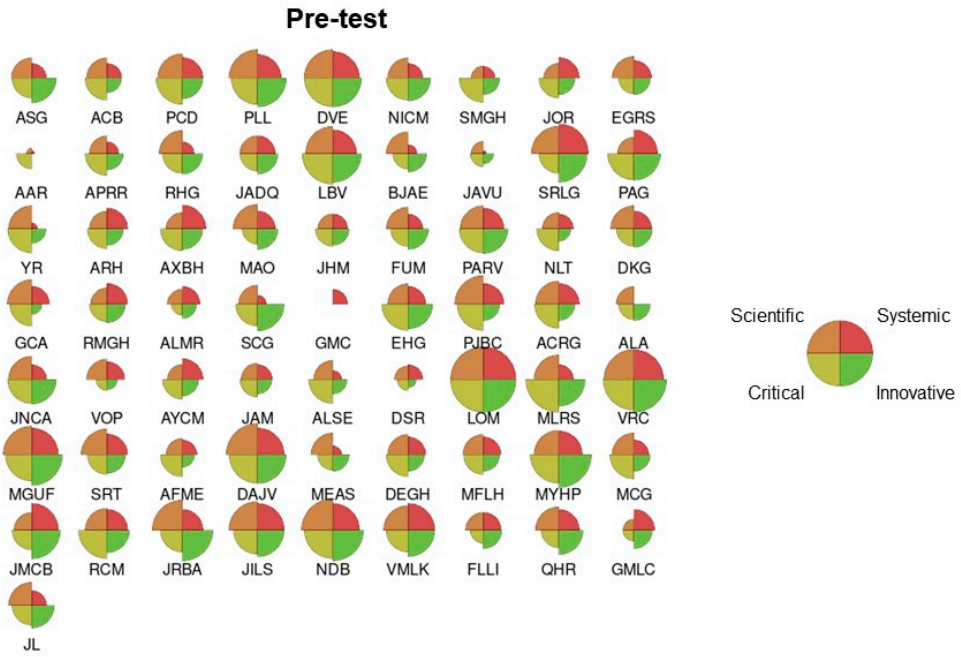


**Figure 5.** Overview of each student in the pre-test scenario.

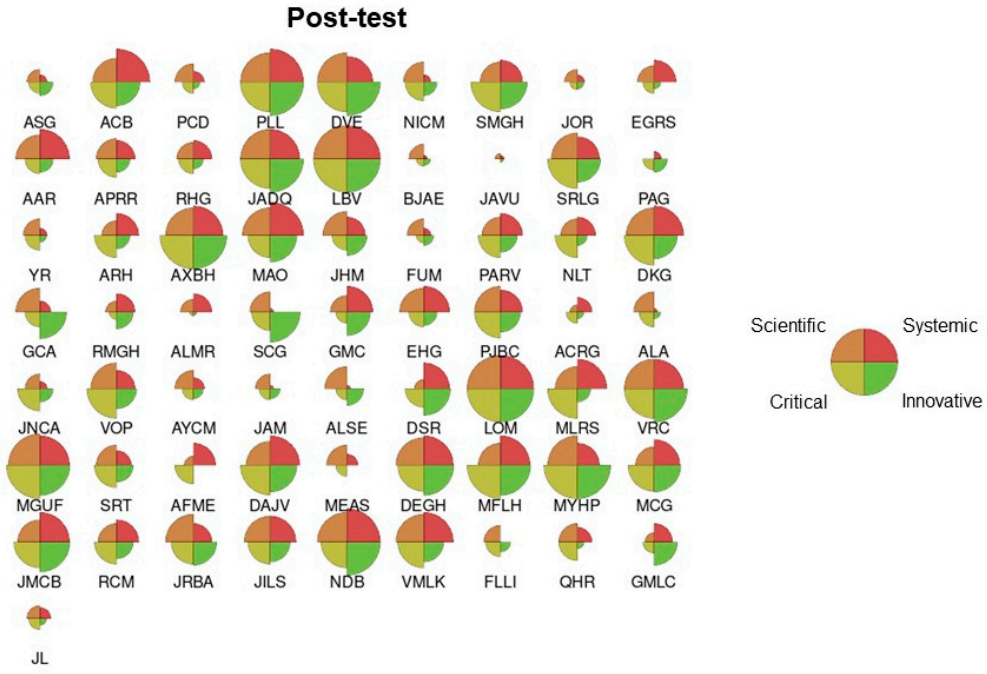


**Figure 6.** Post-test scenario for each student.

These findings are consistent with previous studies, such as those of Meleady et al. (2021) and Manganelli et al. (2019), who emphasied the relationship between cultural and artistic education and how people appreciate and perceive their environment. They also align with the approaches of Halpern (2014) and Dubois-Shaik and Fusulier (2017), who relate cultural knowledge with critical thinking, or the contribution of Shore (1996), who proposes that cultural training develops systemic thinking.

It is recognized that these studies were not conducted in a Latin American context; however, they shed light on studies that are similar to the results obtained here. Currently, no proposals for Latin American studies associated with the indicators and variables

proposed in this article were found, which provides greater originality to these results and opens up the possibility of related future research.

These results indicate that the study's objective was met since a statistically significant improvement and correlation between the cultural formation objective of the class and the students' perceived achievement of the complex thinking competency and its sub-competencies were proven. Although there were outliers, it is generally plausible to infer improvement; that is, the students perceived themselves as more competent after they completed the course, not only in terms of cultural knowledge about Mexico but also their integrated vision of the environment and the challenges they face.

## 4. Conclusions

The primary responsibilities of contemporary educational institutions include identifying and developing tools and techniques that ensure educational quality and enhance students' skills and abilities efficiently and equitably. However, it is not always possible to correlate the official course curriculum with its impact on knowledge acquisition because additional knowledge and competencies often develop parallel to what is expected in a particular course. The present study sought to identify a correlation between cultural training and students' perceived achievement of complex thinking competency and its sub-competencies. In conclusion, our study found a statistically significant correlation.

Admittedly, the present study could be considered limited because of its small population, and it only analyzed students taking one course in one educational institution. Nevertheless, this does not invalidate or diminish the value of its results because it was an exploratory study that opens vast possibilities for future research. As the methodological section noted, these limitations were recommended by the institutional ethics committee, which, based on these results, has authorized expanding the sample for a new study.

The value of these results not only impacts educational theory by providing more information on valuable pedagogical tools for the acquisition and development of competencies, but also provides a novel insight into the value of cultural training in the development of important skills for lifelong learning. Although the present study focused on the measurement of the complex thinking competency and its sub-competencies, it recognizes the possibility that cultural education may impact other competencies, which remains to be investigated in future research.

Finally, it is essential to point out the practical value of this study since its results argue the relevance of generating educational policies that promote cultural education, beyond its historical or artistic value, as proper pedagogical tools for developing transdisciplinary competencies. In an uncertain and changing world, it is necessary to re-evaluate the broad contribution of the various courses that students take during their professional training. Beyond the technical knowledge of the professions, integrated training should promote the development of fundamental complex thinking.

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