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Competency-Based Learning: An Approach Integrating the Domains of Complex Thinking Competency in a Group of Mexican Students

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Abstract

One characteristic of competency-based education is the integration of knowledge, attitudes, and skills that enable individuals to make better decisions and face the challenges of their professional demands. Given this, universities must develop training models that contribute to this integration; otherwise, they cannot ensure that their students are perceived as genuinely competent. Therefore, this article aims to report in depth how the acquisition and development of the competency of complex thinking were configured in a group of students at a Mexican university with a competency-based educational model to corroborate the integral development of necessary cognition, attitudes, and skills considering the gender variable. Based on a multivariate descriptive statistical analysis, this study sought to identify particular characteristics of the sample to understand the acquisition process and student perception of their competency and sub-competencies considering the development of their various components, knowledge, and domains. In conclusion, although the results show that a moderately balanced perception of development has been achieved, there are still areas of opportunity in some aspects, as in the case of the procedural component, especially among female students. In general, the population does not perceive that the knowledge and attitudes they have developed allow them to develop useful processes or skills in professional practice, which may affect their confidence to lead projects or even enter the labor market once they graduate.

Keywords: professional education, educational innovation, future of education, complex thinking, educational gender gap, higher education.

1. Introduction

Discussing competencies in the field of education considers approaching it precisely, as the notion can be so broad that it is not always understood correctly. Competencies involve identifying

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attributes of a person's efficient performance in a process or problem requiring attention, considering both knowledge and how it is configured in viable and appropriate actions and processes for decision-making (Vázquez-Parra et al., 2022). According to Tobón (2010), competency-based education implies meaningful learning for students, guiding them towards an education that integrates theory and practice in the same cognitive process.

Social factors such as globalization and the incursion into Industry 4.0 have meant that training new professionals requires going beyond theoretical knowledge. Therefore, universities and higher education institutions must rethink traditional education, developing competency-based training models that generate broad, flexible, professional profiles where the knowledge acquired is reconfigured to meet various realities and needs. For Le Boterf (2000), competencies are combinatory knowledge, in which the focus is not on knowledge but the learner, enabling specialized knowledge to be mobilized in the multiple situations the individual faces.

For universities, the graduates' professional profiles must become more flexible, valuing the capacity to adapt to different situations, which increases their potential to face future challenges. Therefore, competency training becomes relevant as it allows professionals to have a repertoire of skills, knowledge, and abilities to apply to different contexts and work situations (Yao, Tuliao, 2019). However, this attractive approach is also complex since the multidimensional nature of competencies implies that their training process should consider all their cognitive, attitudinal and procedural elements if the aim is indeed to develop these capacities in future professionals (Sá, Serpa, 2018).

Thus, a competent individual can mobilize various elements to face a challenge, and educational institutions must integrate these components. Based on the above, this article aims to report in depth how the acquisition and development of the competency of complex thinking were configured in a group of students at a Mexican university with a competency-based educational model to corroborate the integral development of necessary cognition, attitudes, and skills considering the gender variable. The competency of complex thinking was selected since it is a general competency with the initial characteristic of involving a systematic collaboration of elements and sub-competencies (systemic thinking, critical thinking, scientific thinking and innovative thinking), which makes identifying the components more feasible. Based on a multivariate descriptive statistical analysis, this study sought to identify particular characteristics of the sample to understand the acquisition process and student perception of their competency and sub-competencies performance considering the development of its various components, knowledge, and domains.

1.1. Competencies and their components

The study of competencies in education implies considering two different approaches. On the one hand, one must consider the linguistic contribution of Chomsky, who linked this notion to the verbal capacity of individuals to combine their knowledge of languages and capacity for expression, which enables them to produce and recognize language (Wargadinata et al., 2021). On the other hand, entrepreneurial training focuses on constructing know-how based on cognitive elements that develop as part of a training process (Handrianto et al., 2021). In both cases, competencies imply the interaction of components that enable a person to develop a specific capacity to respond to a need, integrating their skills and intellect.

Although the notion of competencies had already been used in the educational area, especially in the field of personnel training since the 1930s, it would not be until the 1970s that competency-based training would take on a functional focus, paying attention to the relevance of developing knowledge, attitudes, and skills as the fundamental pillars of any competent person's optimal performance (Martínez Casanovas et al., 2022). For Parveen, Nazir and Zamir (2021), competencies require the development of certain aptitudes that influence how people think and behave in one situation and another, which impacts the development of their skills. In this same sense, Glaser (2021) had already considered that knowledge was not enough to fully achieve competency since people's disposition and conduct also impact the correct performance of an activity. The latter had already been pointed out by Lasnier (2000), who indicated that competency is the complex knowledge resulting from integrating capacities and skills (cognitive, affective, psychomotor or social) and knowledge, which must interact effectively to address specific situations.

Thus, three knowledge or other domains can be proposed that all competencies share (Vázquez-Parra et al., 2023):

- Attitudinal domain refers to those values, attitudes, and principles that regulate human action and are necessary in a complex world. It refers specifically to the self.
- Conceptual domain is the minimum knowledge an individual requires to know how to carry out a process. It refers specifically to knowing.
- Procedural domain comprises the abilities, skills, techniques, strategies, and procedures that allow the practical implementation of knowledge in specific situations. It refers to know-how.

Although an essential feature of any competency is the relationship between its cognitive and skills elements, the attitudinal factor cannot be excluded because competencies effectively involve applying knowledge in the development of processes while requiring values and principles for effective task performance in a specific environment (Woodcock et al., 2021). Thus, a competency's relevance does not lie just in acquiring knowledge or developing skills but also in integrating elements from a sense that the individual has in a specific situation (Ramos et al., 2021). Therefore, it is necessary to adopt an orientation that focuses to a large extent on the individual, which is a necessity for educational institutions wishing to develop competency-based training programs.

1.2. Complex thinking competency

In addition to considering components or types of domains or knowledge, competency-based learning should consider three levels (Kulik et al., 2020). The first focuses on acquiring indispensable intellectual skills, which may have been acquired in previous educational stages, such as those related to language, logic, or mathematical thinking. On a second level, generic competencies of professional life are considered, referring to cognitive skills and processes that every professional should have, i.e., transversal competencies such as social intelligence, complex thinking, and communication. Finally, on a third level, specific competencies must be considered, directly related to acquiring skills and processes specific to each profession. Under this "level" approach, the formation of competencies in various domains does not necessarily occur in a single educational stage. So, universities must not lose sight of these moments when training their students, as it is in these stages that the skills that underlie professional training are acquired and developed (Rasulova, 2020).

As pointed out, the competency of complex thinking is one of the generic or transversal competencies that in recent decades has aroused greater interest on the part of educational studies, as it is considered to be a competency that is extremely valuable in the face of the global, diverse, fluid, and flexible realities faced by today's professionals (Tobón, Luna-Nemecio, 2021). The competency of complex thinking is the ability of an individual to implement integrative reasoning that allows them to analyze and synthesize information to face challenges, solve problems, or make decisions during their lives. Complex thinking or reasoning considers quantitative, qualitative, algorithmic, analogical, contextual, combinatorial, fuzzy, imaginative, provisional, heuristic, and ethical analyses (Tecnologico de Monterrey, 2019).

It is noteworthy that the importance of complex thinking as a professional competency lies in the capacity of people to understand the phenomena of their reality integratively, considering the dynamics and interaction among all its elements, going beyond the sum of its parts (Silva Pacheco, Iturra Herrera, 2021). In addition, complex thinking is a relevant general competency for any professional, as it enables them to develop a strategic, systemic and interdisciplinary vision in their analysis and rational choice processes (Morin, 1990).

Just like competencies in general that have different components or domains, the competency of complex thinking comprises four related sub-competencies with particular elements that broaden the perspective of each situation when it is analyzed: systemic thinking, scientific thinking, critical thinking, and innovative thinking (Cruz-Sandoval et al., 2023a; Vázquez-Parra et al., 2023).

Systems thinking is the ability to analyze problems integrating inter- and transdisciplinary vision, understanding the dynamics of the factors and elements that comprise it (Nagahi et al., 2019). On the other hand, scientific reasoning is based on objective, validated, and standardized methods that can be implemented as routes for analyzing the environment, seeking to ensure that decisions are made within a framework of arguments and concrete evidence (Koerber, Osterhaus, 2019). On the other hand, critical thinking allows people to evaluate reality and existing information, discerning what is not said or what can be stated differently (Cui et al., 2021). Finally, innovative thinking considers mental processes of search and discovery that allow the person to situate the problem and visualize it from different angles and perspectives (critical thinking) to come up with original and feasible solutions (Zhou, 2021).

1.3. Complex thinking and gender

According to Antonio, Chang, Hakuta, Kenny, Levin and Milen (2004), people's characteristics such as race, gender, age, and social or economic status can influence how skills or competencies are perceived in a challenging situation, with the environment being a determining factor when assessing the ability to solve a problem. However, beyond perception, personal factors can influence acquiring and developing a competency. If the training environment is not ideal or is biased, it would be natural for skills to develop in a particular direction and not another. For Arredondo-Trapero, Vázquez-Parra, and Velázquez-Sánchez (2019), there is no significant difference between men and women regarding their ability to develop scientific thinking. However, there are still differences in access to resources and support to enter areas related to science and technology for gender reasons. This generates uncertainty among women when they practice the knowledge acquired in their training.

Thus, although universities may provide equal opportunities for their students, it does not prevent the social environment or cultural patterns from influencing the acquisition and development of competencies. At the end of the day, future graduates' performance and work practice occur in social environments beyond the safety of the classroom. In this sense, Janusz, Jósefik, and Peräkylä (2018) point out that female students tend to develop a systemic vision of reality better than men since, in patriarchal environments (such as Latin America), they are attributed care and attention tasks usually rooted in the cultural imaginary that end up influencing their professional skills and their interactions with colleagues and staff in management tasks. The same happens with critical thinking, which according to Onditi and Odera (2021), also shows women's superior development when they have to rethink their actions, decisions, and work due to the constant questioning of a hegemonic environment that is primarily male-dominated. For Marmo (2017), women's process of gender self-construction leads them to develop a more critical sense than their male counterparts, which may influence their perception of their knowledge, skills, and achievements.

The above is not intended to indicate a generalized gap in the development of competencies between men and women, but, at least in the case of complex thinking, differences can be attributed to how the level of achievement of its sub-competencies is displayed and perceived (Cruz-Sandoval et al., 2023b). Thus, this article seeks to delve into how acquiring and developing the competency of complex thinking and its sub-competencies were configured in a group of students at a Mexican university, which in recent years had deployed a competency-based training model, intending to describe how this training process is configured based on its components or domains. The aim is to identify whether there are differences between male and female students in perceiving their level of achievement, which, in the long run, may influence their ability to face professional challenges.

2. Materials and methods

A convenience sample of 195 students in a technological university in Mexico that has adopted a competency-based educational model included 120 males and 75 females. Students from different disciplinary areas and semesters were considered. The study was conducted between February and April 2022 with a convenience sample of students taking general education courses. Participants ranged in age from 18 to 23 years old. A self-administered questionnaire answered via Google Forms was administered and answered voluntarily by the students.

Table 1. Participant data by gender

Men		Women		Total	
N	%	n	%	n	%
				195	100
26	47	29	53	55	28
10	38	16	62	26	14
84	74	30	26	114	58

2.1. Instrument and data analysis

The eComplexity instrument aims to measure the perception of the participants' level of mastery of reasoning-for-complexity and its sub-competencies. It is an instrument that has been validated theoretically and statistically by a team of experts in the field (Castillo-Martínez et al., 2021). The instrument comprises 25 items divided into four sub-competencies: systemic, scientific, innovative, and critical thinking. Each of these four sub-competencies was further divided into three areas: knowledge, skills, and attitudes or values. Its implementation is self-applicable, and each item is assessed using a five-level Likert scale.

As for data processing, a multivariate descriptive analysis was carried out using the computer software R (R Core Team, 2017) and Rstudio (RStudio Team, 2022).

First, arithmetic means and standard deviations were calculated to determine the students' perception of each sub-competency of complex thinking by gender. To complement this analysis, we performed a boxplot analysis (also known as a box and whiskers diagram). This analysis allowed us to know how the means of the students' perception of the sub-competencies were dispersed and the symmetry and outliers of their responses (Williamson, 1989). We also conducted a principal component analysis (PCA). This analysis allowed us to know the behavior of our observations of the students, avoiding collinearity problems of our variables. This was done by expressing the data's maximum variability in a new set of independent and uncorrelated components according to the original variables. In this sense, as many principal components as variables would be analyzed (Cruz-Sandoval et al., 2023). Subsequently, a Biplot analysis was performed to complement the PCA. This analysis allowed us to know more graphically the behavior of our observations (students) using the components that captured the maximum variability of our data (Gabriel, 1971). Thus, a Biplot of form $\alpha = 1$ was performed, allowing us to illustrate better the behavior of the observations (Cruz-Sandoval et al., 2023). Finally, a BoxPlot analysis was performed for each sub-competency domain area (attitudes or values, knowledge, and skills). Finally, a statistical significance analysis was performed through the t-test on the difference in mean values of the perception of complex thinking sub-competencies between men and women.

3. Results

Table 2 shows the sample population's total means and standard deviations, considering the gender variable in the students' perception of performance in developing the competency and sub-competencies of complex thinking. The results showed that women had a higher perception regarding the development of this competency in general and in each sub-competency, highlighting critical thinking and systems thinking (mean of 4.19 and 4.16, respectively). Overall, it was shown that the sample perceived a higher development of the sub-competencies of systemic and critical thinking (4.13 and 4.08) and a lower perception of scientific thinking (3.61).

Table 2. Means and standard deviations of the complex thinking competency and sub-competencies, men and women

	Men		Women		Total	
	Means	StD	Means	StD	Means	StD
Complex Thinking	3.87	0.56	4.00	0.67	3.92	0.61
Scientific Thinking	3.54	0.62	3.72	0.74	3.61	0.67
Critical Thinking	4.01	0.48	4.19	0.64	4.08	0.55
Innovative Thinking	3.82	0.50	3.94	0.64	3.87	0.56
Systemic Thinking	4.11	0.47	4.16	0.57	4.13	0.51

For a broader picture, Figure 1 shows the boxplot analysis of the complex thinking competency and sub-competencies by gender. In it, we can observe the outliers and the dispersion of students in each sub-competency. This figure shows that more females perceived themselves to have developed the sub-competencies than males. Also, it can be observed that women had a behavior of extremes, i.e., women perceived themselves as very low in the sub-competencies while others perceived themselves as very high (first and fourth quartiles). On the other hand, the values for men's perceptions show a more balanced behavior, primarily concentrated in the second and third quartiles.

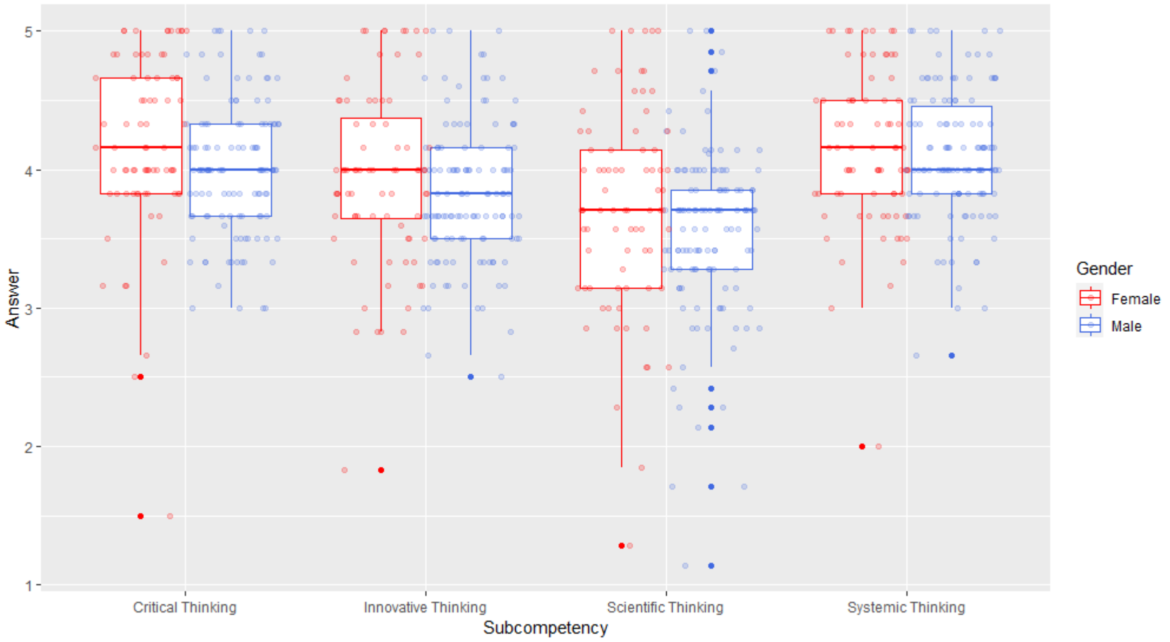

Fig. 1. Boxplots of the complex thinking competency and sub-competencies, men and women

Regarding principal component analysis (PCA), we observed that the Principal Component one (PC1) and Principal Component two (PC2), together explained 85 % of the total variability in our data (Table 3). PC1 explained 73 %, while PC2 captured 11 %. Likewise, we observed that PC1 positively correlated with critical thinking and innovative thinking. In this sense, PC1 would explain students' perception of their ability to evaluate reality and existing information, discerning what is not said and what can be stated differently. Likewise, this component could explain students' perception of their ability to propose original and feasible solutions to different problems. On the other hand, PC2 had a high correlation with the sub-competency of scientific thinking. This component explains the students' perception of their ability to propose solutions within a framework of objective, validated, and standardized methods, seeking to make decisions with concrete arguments and evidence.

Table 3. Principal Component Analysis Matrix. Complex thinking sub-competencies, men and women

	PC1	PC2	PC3	PC4
Scientific Thinking	0.47	-0.77	0.05	0.41
Critical Thinking	0.51	0.20	0.77	-0.31
Innovative Thinking	0.51	-0.06	-0.58	-0.62
Systemic Thinking	0.49	0.59	-0.24	0.57
Standard Deviation	1.71	0.69	0.55	0.52
Proportion of Variance	0.73	0.11	0.07	0.07
Cumulative Proportion	0.73	0.85	0.93	1.00

Figure 2 shows the analysis of the Biplot graph. This graph allows us to understand better our students' behavior concerning the sub-competencies in the components that capture the maximum variability. The figure color-codes the students' gender. It shows the different sub-competencies of complex thinking. This graph illustrates that the sub-competencies coming out of the vertex very close to each other are the most correlated, and the sub-competencies farther apart are not correlated.

In this sense, the sub-competencies of systemic and scientific thinking were opposite. However, critical thinking and innovative thinking had some correlation. Since the intention was to observe the students' behavior, the Biplot presented here corresponds to a Bipot of form (α = 1). It can be observed that the behavior of men is more centered (except for some outliers), while women's behavior is more dispersed. Likewise, we see that a small group of women had a higher perception of their complex thinking than men. That is, the women's perception of systemic, scientific, innovative, and critical thinking was higher than men's.

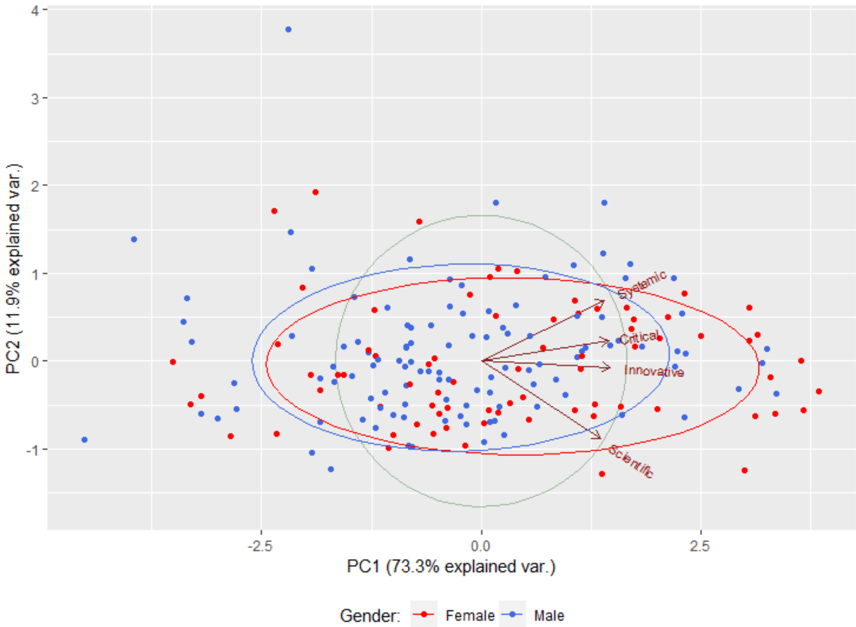

Fig. 2. Biplot. Complex thinking and its sub-competencies, men and women. Biplot of form (α = 1)

On the other hand, Table 4 shows the arithmetic mean and standard deviation of each domain area by sub-competency. In this sense, one can observe that concerning Scientific Thinking, the domain with the highest mean value corresponded to attitudes or values in men and women, being attitudinal (3.95 and 3.90, respectively). Similar behavior in the knowledge domain presented itself in the other sub-competencies (higher in systemic thinking). That is to say, the highest average value of attitudinal being was obtained compared to knowledge and knowing how to do. On the other hand, the lowest mean values in women and men stand out in the three dominant areas of the sub-competency of critical thinking.

Table 4. Means and standard deviations of sub-competencies and their domains for men and women

			Men	Women
Sub-competency	Domain/knowledge	Item	Means	StD
Scientific Thinking	Knowledge	7,8,9	3.49	0.93
Scientific Thinking	Skills	10,11,12	3.45	0.90
Scientific Thinking	Attitudes or Values	13	3.95	0.88
Critical Thinking	Knowledge	14,15	4.06	0.71
Critical Thinking	Skills	16,17	3.89	0.78
Critical Thinking	Attitudes or Values	18,19	4.08	0.85
Innovative Thinking	Knowledge	20,21	3.81	0.72
Innovative Thinking	Skills	22,23,24	3.81	0.79
Innovative Thinking	Attitudes or Values	25	3.93	0.72
Systemic Thinking	Knowledge	1,2	4.03	0.68
Systemic Thinking	Skills	3,4	4.03	0.83
Systemic Thinking	Attitudes or Values	5,6	4.26	0.73

Figure 3 shows the Boxplot analysis of each domain of the scientific thinking sub-competency. The mean values of the students' perception in the dominant areas indicate that men had consistent minimum values for attitudes or values and skills, while women presented minimum values in knowledge (men perceive themselves to be higher in knowledge). Likewise, Figure 3 indicates that women had fewer attitudes, values, and skills variations. In other words, women had a higher perception in these last two domains than men.

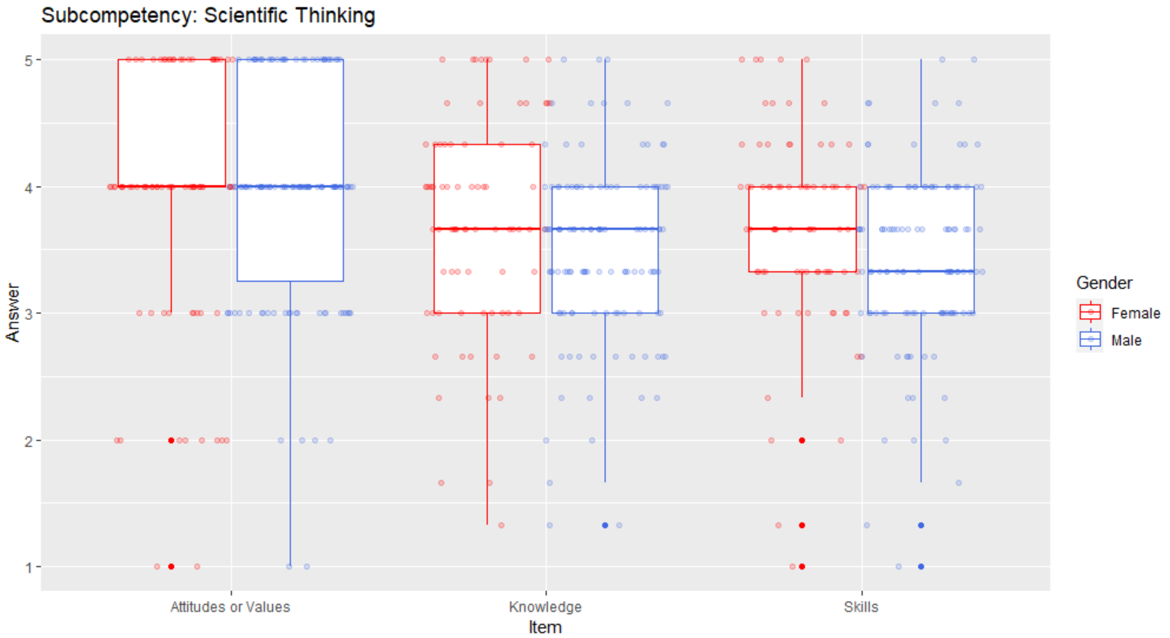

Fig. 3. Boxplots of the scientific thinking sub-competency and its domains for men and women

On the other hand, Figure 4 shows the domains of the critical thinking sub-competency, where one can observe that the women's perception was higher in attitudes and values, having the highest consistent minimum value in the first quartile. Similarly, women perceived themselves better in knowledge compared to men. Regarding skills, women perceived themselves as less capable, presenting the lowest consistent value in the analysis.

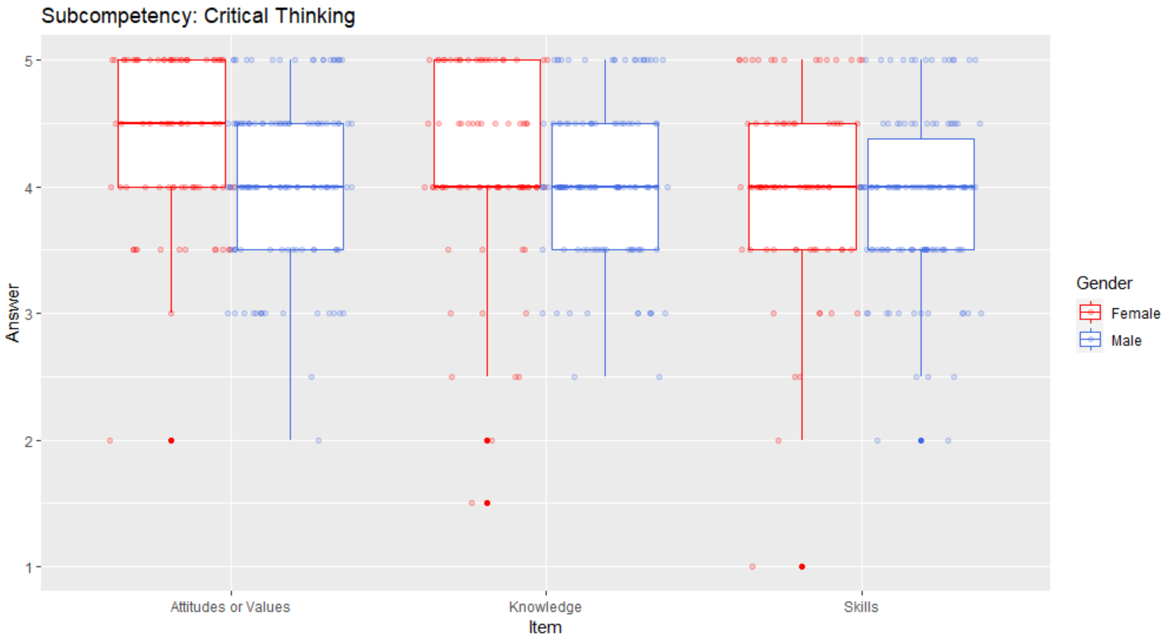

Fig. 4. Boxplots of critical thinking sub-competency and its domains, men and women

Concerning Figure 5, the boxplot analysis of innovative thinking and its domains indicates that women perceived themselves to be higher in skills, while men perceived themselves better in attitudes and values and knowledge. Likewise, the medians of the means obtained for students' perception in this sub-competency produced similar values in the three domains of this sub-competency.

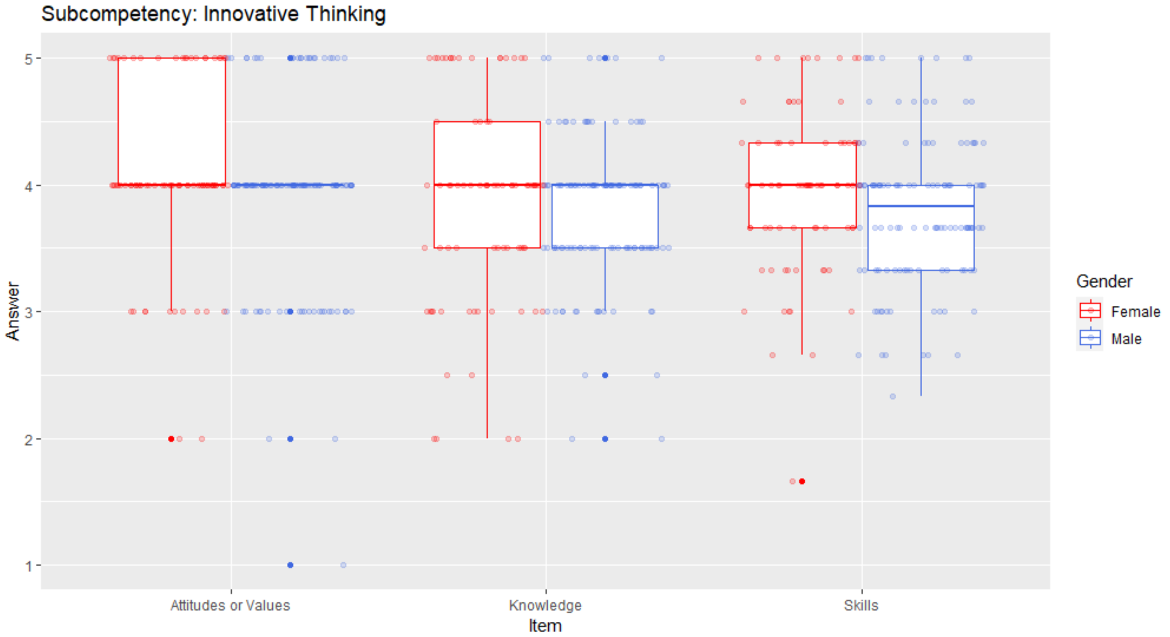

Fig. 5. Boxplots of the innovative thinking sub-competency and its domains of men and women

Figure 6 shows the boxplot analysis of systems thinking and its domains. Although the medians of the mean values of students' perceptions in this sub-competency were very similar, women perceived themselves better in attitudes or values and skills. On the other hand, men perceived themselves better in the knowledge domain of this sub-competency.

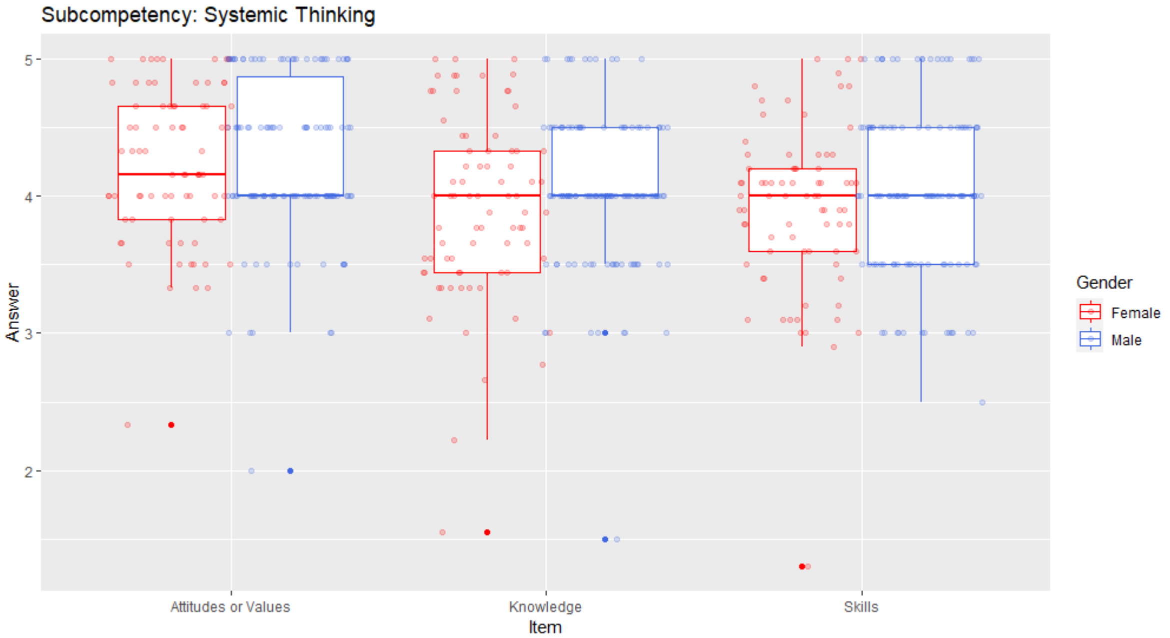

Fig. 6. Boxplots of the systems thinking sub-competency and its domains for males and females

Finally, Table 5 shows the analysis of the significant differences in the mean values of the perceived achievement of complex thinking and its competencies between men and women. Mainly, the table shows significant differences in the sub-competency of critical thinking. This could be due to the fact that women present better attitudes and values than their male peers as explained above.

Table 5. Results of significant differences between men and women in the perception of achievement of complex thinking sub-competencies (t student)

	t	df	p-value
Scientific Thinking	-1.8219	142.13	0.07057
Critical Thinking	-2.1859	130.25	0.03061
Innovative Thinking	-1.3688	136.03	0.1733
Systemic Thinking	-0.55668	138.38	0.5786

4. Discussion

Most notable in this study is the differences in how the level of achievement of the complex thinking competency was perceived between men and women. In general, we note that the average of the perception of achievement of the competency (Table 1) shows that women achieved a higher average (4.00) than men (3.87) and that this is repeated in all the sub-competencies: critical thinking (4.19-4.01), innovative thinking (3.94-3.82), systems thinking (4.16-4.11), and even scientific thinking (3.72-3.54), which is in line with previous studies of the theoretical framework (Cruz-Sandoval et al., 2023a; Di Tullio, 2019; Heybach, Pickup, 2017; Tabo et al., 2021).

The above forced us to delve deeper into the results, carrying out a Boxplot graph that allowed us to analyze each sub-competency in greater detail. As can be seen in Figure 1, the higher means are confirmed in the group of women in critical thinking, innovative thinking, and systems thinking; however, in scientific thinking, although the mean is higher in the group of women (3.54-3.72), so is the standard deviation (0.62-0.74), indicating that the apparent difference is not statistically significant. An additional point of this sub-competency is a greater tendency for women's responses to be more dispersed in both high and low perception, so, although the mean was higher than that of men, the total balanced out in the end. This can also be seen in Figure 2, which shows that the women gave the most dispersed responses, providing the highest and lowest indicators. In contrast, men had results closer to the average. In a previous study conducted with this population, Vázquez-Parra, Castillo-Martínez, Ramírez-Montoya & Amézquita-Zamora (2022) identified that, although the means made it seem that there was a better perception by the group of women, the standard deviation balanced the results, concluding that there was no statistically significant difference between the two genders.

However, considering that this study was applied in a university that had adopted a training model to develop competencies, it aimed to delve deeper into the mastery levels of each sub-competency, seeking to verify, as Tobón (2010) pointed out, whether significant learning that integrates attitudes, knowledge, and skills actually occurred.

First, Figure 3 shows the students' perception in the domains of the sub-competency of scientific thinking. The data for the group of women showed a more positive trend than the males, especially in the cognitive aspect (3.49-3.72). At the level of attitudes, men outperformed women (3.95-3.90), but the standard deviation compensated for this. Another noteworthy mention is that the domain related to skills and processes yields the lowest data in both populations (3.45-3.68), especially in the male population (3.45), which makes us question that, at least in this sub-competency, there was an imbalance in the integration of this type of thinking. In general, the perception of the sample population, both men and women, was that they had sufficient knowledge and attitudes to use objective, valid, and standardized methodologies. However, at least the men in the sample negatively perceived their ability to put these attitudes and knowledge into practice.

Regarding critical thinking (Figure 4), women exhibited a clear positive tendency in all three aspects (Table 4), with the highest data in the attitudinal aspect (4.08-4.36) and the lowest in the skills and processes part (3.89-4.03). It is essential to mention that men's means (3.95, 4.06, 4.08) showed a better balance than women's (4.18, 4.03, 4.36), which allows us to appreciate a more even development of their three domains. It is important to consider that among women, there was a lower development in the skills aspect (4.03), which reveals a problem when it comes to putting knowledge and attitudes into practice.

A different situation was found with innovative thinking (Figure 5), where there was a very balanced development in the three domains for both men and women. Although the attitudinal part produced the highest scores (3.93-4.09), they were very close to the cognitive scores (3.81-3.86) and the skills domain (3.81-3.96). In contrast to the previous sub-competencies, here the skills scores were higher than the cognitive part in the female group (3.96-3.86), giving the same results in the male group (3.81-3.81). At least in innovative thinking, it is clear that integration among the three skills was achieved, resulting in significant learning (Tobón, 2010). Finally, systems thinking (Figure 6) showed a balance between the cognitive and skills aspects of the participants' learning processes, both for men (4.03-4.03) and women (4.01-4.09), with better results in the skills and processes part. However, following the general trend, attitudes and values produced the highest results (4.26-4.37). In the case of women, it is interesting that the means reflected a higher positive attitude than men in this sub-competency, which may respond to the attributes that are culturally assigned to them in a region such as Latin America (Janusz et al., 2018).

Thus, based on the above, we can point out a tendency in the four sub-competencies to have more positive results in the attitudinal aspect, with women generally producing the highest data. Only in scientific thinking did men perceive themselves to have a better attitude than women, which may respond to the confidence and support usually given to men in regions such as Latin America in science-related areas (Arredondo et al., 2019). In terms of scientific and critical thinking, there was a negative trend in how the skills aspect is being developed, in contrast to knowledge and attitudes, which shows a lack of integration of knowledge or domains in these sub-competencies.

5. Conclusion

An essential feature of competency-based training lies in the need to integrate knowledge, attitudes, and skills to achieve significant learning. As pointed out in the theoretical framework, the contemporary world demands that new professionals understand the problems and have sufficient skills and attitudes to face them, make decisions, and develop feasible solutions.

Therefore, the present study sought to describe how a group of students training in a Mexican university using a competency-based educational model perceived the level of development of complex thinking, its sub-competencies, knowledge, or domains. The intention was to identify whether the training process contributed to acquiring and integrating competencies or whether it continued to replicate training primarily focused on acquiring knowledge.

In conclusion, although the results showed that a moderately balanced student perception of development was achieved, there are still areas of opportunity procedurally, especially among female students. In general, the population did not perceive that the knowledge and attitudes they developed allow them to develop valuable processes or skills for professional practice, which may affect their confidence to lead projects or even enter the labor market once they graduate. In the specific case of women, this lack of integration may contribute to the low presence of women in professions with a highly applied profile, segregating them to more administrative positions, usually with lower development rates. In operational professions, it is not enough to be knowledgeable; it is necessary to be perceived as competent.

We acknowledge the study limitations of the small sample size and the fact that it was only carried out in one educational institution. However, we consider that the results yielded significant data that can be replicated in other settings and larger populations. We also understand that it may be a limitation that the instrument focused on perception and not so much on the level of performance. However, perception is a determining factor in forming competencies, considering that even if the students have the competency, they may be limited if their perception is biased or pessimistic about what they know or how to do.

In practical terms, we are confident that these results open up the possibility of new lines of research focused on competency training and providing an initial platform for public policies and educational programs for professional development. It is not enough to state that one wants to develop practical professional skills for life; it is necessary to ensure that the model adopted achieves the comprehensive training that characterizes competencies.

6. Conflict of interest

All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report.

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