

Article

Social Entrepreneurship and Complex Thinking: Validation of SEL4C Methodology for Scaling the Perception of Achieved Competency

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Abstract: This article aims to show the validated results of implementing a self-created methodology for developing the perceived achievement of social entrepreneurship competency and how this methodology is equally valid in developing the perceived achievement of complex thinking competency. Presenting a multivariate descriptive statistical analysis, this article offers the results of an educational intervention carried out on a sample group of students from a Mexican university before and after implementing the SEL4C (Social Entrepreneurship Learning for Complexity) methodology (developed by the Interdisciplinary Research Group IRG Reasoning for Complexity R4C at the Institute for the Future of Education IFE of the Tecnológico de Monterrey). It corroborates that the proposed methodology impacts the perceived achievement of social entrepreneurship competency and its sub-competencies and also manages to develop the perception of achievement of the complex thinking competency. This article contributes to the studies associated with the formation of competencies and the social entrepreneurship approach as a valid pedagogical tool for developing transversal skills.

Keywords: professional education; educational innovation; future of education; complex thinking; social entrepreneurship; higher education



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1. Introduction

In recent years, the economic situation resulting from the COVID-19 pandemic has called into question the permanence of many projects that prioritize countries' social needs. One of the first items to suffer budget cuts were projects associated with humanitarian causes. Therefore, more than ever, there is a need to promote new models that respond and attend to social causes; social entrepreneurship is more efficient and sustainable than philanthropy and altruistic actions, according to the Ashoka organization [1].

In this sense, educational institutions that train in entrepreneurship must pay greater attention to the social attributes of the projects they manage and recognize that the training of social entrepreneurs can be an excellent way to respond to the social demands of their environment and to the responsibility they have institutionally to address international challenges such as the Sustainable Development Goals. However, training in social entrepreneurship requires specialized human resources beyond business training. Unlike traditional entrepreneurship, social entrepreneurship has a humanistic component that involves developing skills such as empathy, recognition, and critical sense, among others. Instead of traditional processes that focus on the construction of projects, social entrepreneurship must emphasize the development of the entrepreneur's capabilities. Beyond the entrepreneurial idea, the social entrepreneur must be sensitive to the problem being addressed and consider the potential users, the social value generated, and the impact the proposal has on improving people's quality of life. Therefore, at a formative level, social entrepreneurship must be associated with developing multiple competencies and derived skills.

Considering the challenges that training in social entrepreneurship can present and the need for universities to adopt training proposals, a group of researchers at a technological university in western Mexico developed the SEL4C (Social Entrepreneurship Learning for Complexity) methodology that not only triggers and generates social entrepreneurship ideas but also promotes the acquisition and scaling of social entrepreneurship competencies and complex thinking. This methodology emphasizes the importance of developing capabilities without losing sight of the fact that entrepreneurial proposals should have social value.

Thus, this article aims to show the results of validating the SEL4C methodology in a sample group of students from a technological university in western Mexico. The intention is to demonstrate that this methodology facilitates the ideation of social entrepreneurship proposals and develops a more excellent perception of achieved social entrepreneurship and complex thinking competencies. This competency-based methodology focuses on developing individuals and opts for measuring perceived achievement, not just the scaling of skills. This decision is based on the principle that the level of competency may be affected if the individuals do not perceive themselves as truly competent. This text reports the results of this educational intervention and its impact based on descriptive statistical analysis.

2. Theoretical Framework

2.1. Social Entrepreneurship Competency

Social entrepreneurship competency fostered by universities assumes a pedagogical and institutional orientation that promotes the mobilization of knowledge, capabilities, skills, and attitudes that are indispensable in actions that respond to environmental problems, generate innovative solutions with added value, and positively impact society [2]. According to the Global Entrepreneurship Monitor (GEM), educational institutions are essential in promoting entrepreneurship because they are part of an environment where students acquire the necessary tools to materialize innovative ideas that respond to complex needs [3]. Beyond entrepreneurial work, the university forms autonomous people who are socially responsible for the environment and the economy [4].

Entrepreneurial training within universities has grown since the 1980s, orienting its training processes toward generating business ideas and emphasizing the training of entrepreneurs and their skills. However, it is recognized that entrepreneurial actions from a social entrepreneurship approach go beyond the formation of business enterprises [5]. According to Sáenz & López [6], the competencies needed to train in social entrepreneurship (COEMS) are classified into four blocks: (1) competencies related to the task or work to be performed; (2) competencies for social relations; (3) philosophical and ethical competencies and; (4) competencies to develop personal skills. The four blocks, in turn, are subdivided, as shown in Figure 1.

García-González, Ramírez-Montoya, de León, and Aragón [7] point out that the substantive tasks of higher education institutions that resume entrepreneurship training require the inclusion of entrepreneurial-skills-training processes. Hence, training in social entrepreneurship calls for including cognitive, procedural, and attitudinal skills that promote innovation with added value to society through economically and administratively sustainable ideas and, in turn, develop social and personal skills [8].

In addition to the above, the transdisciplinary approach is considered necessary in the formation of social entrepreneurship, given that the cognitive competency underlying any entrepreneurship requires knowledge of both business and skills related to the diverse problems of the environment, which leads to the integration of visions and disciplines, i.e., humanities, social sciences, health sciences, and creative industries [9]. The present study is based on the proposal of García-González, Ramírez-Montoya, de León, and Aragón [7], who point out four sub-competencies related to social entrepreneurship, as shown in Figure 2.

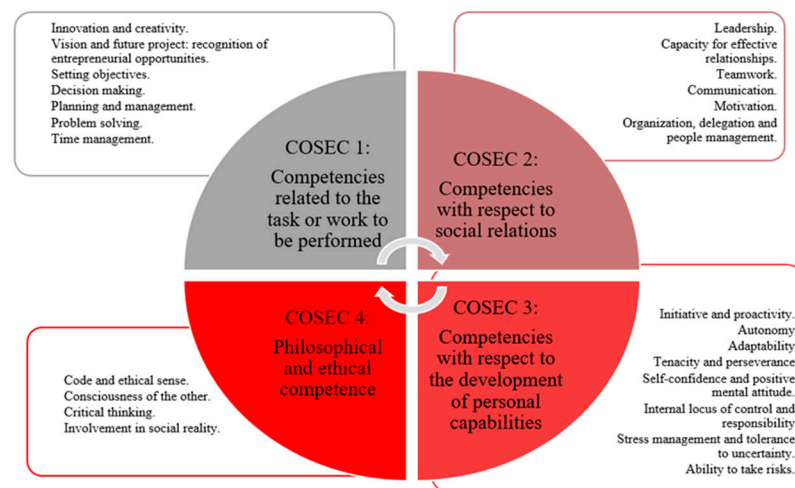


Figure 1. Classification of Social Entrepreneurship Competencies (COSEC). Source: Sáenz & López, [6]: p. 166.

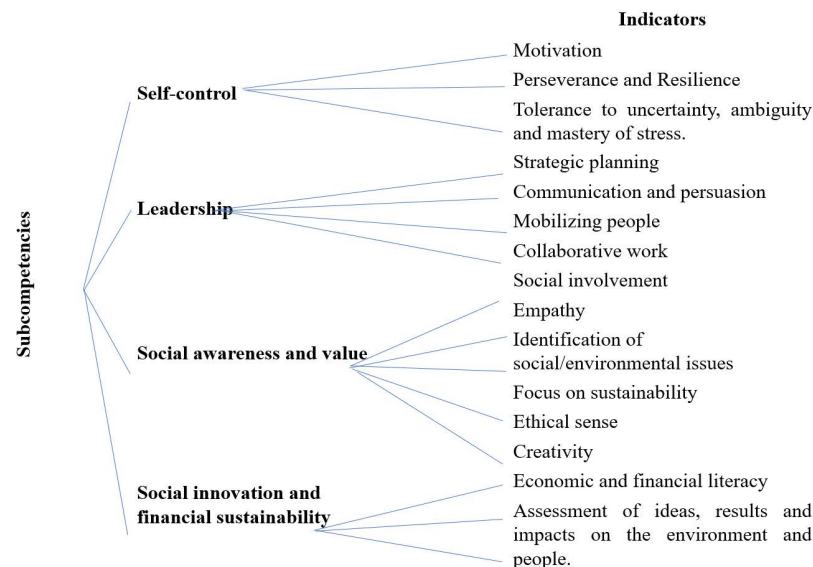


Figure 2. Social Entrepreneurship Competency and its sub-competencies and indicators. Source: García-González, Ramírez-Montoya, de León, and Aragón [7].

As shown in the figure above, the social entrepreneurship competency involves the development of various competencies and skills that, in turn, link with the ideation process and project beyond entrepreneurship. Hence, it becomes possible to consider correlations between social entrepreneurship and other competencies, such as complex thinking.

2.2. Complex Thinking Competency

The competency of complex thinking is understood as a person's ability to carry out multidimensional analysis and reasoning through comprehensive cognitive processes, which provide elements to recognize contextual challenges in constant movement [10]. In the professional field, the competency of complex thinking grants the ability to contemplate and address problems interconnectedly and systemically, considering all the aspects and actors involved and the dynamics between them [11]. The consideration of this worldview is what Morin [12] calls competency with complexity.

In professional training, complex thinking is considered a generic competency, given that, although it has professional relevance, it is not linked to a particular discipline because the direct impact derives from transversality [13]. Thus, critical thinking, problem-solving, communication, collaboration, creativity, innovation, and intercultural skills, among others,

comprise the development of complex thinking and are necessary for decision-making in the exercise of the profession [14]. Therefore, complex thinking is determinant for problem-solving and using people's intellectual resources to face daily vicissitudes and propose value solutions, i.e., social entrepreneurship [15].

Within the competency of complex thinking, four sub-competencies or subtypes of thinking contribute to the comprehensiveness of people's reality. Each thought provides cognitive and attitudinal tools and basic skills for developing complex thinking. The four sub-competencies or subtypes of thinking are (1) systemic thinking, (2) critical thinking, (3) scientific thinking, and (4) innovative thinking, each having particular characteristics as shown in Table 1.

Table 1. Sub-competencies of complex thinking.

Sub-Competency	Characteristics
Systemic Thinking	According to Jaaron & Backhouse [16], systemic thinking is associated with the ability to analyze problems holistically and integratively; therefore, it includes inter- and transdisciplinarity. Hence, systemic thinking interconnects reality, considering the complexity that reality possesses and the multiple and diverse elements that comprise it.
Critical Thinking	This type of thinking is considered a sub-competency that facilitates the evaluation and validity of reasoning that underpins the generation of logical judgments for a situation or a problem, deconstructing existing paradigms of current events [17].
Scientific Thinking	Scientific thinking is a problem-solving sub-competency based on a worldview and methodology that uses validated and standardized processes in the scientific community to research concrete evidence; therefore, the person resolves questions and problems of the environment by integrating various cognitive processes, i.e., inductive and deductive reasoning, formulation and testing of hypotheses, among others [18].
Innovative Thinking	This sub-competency uses the mental processes of search and discovery that, according to Zhou [19], facilitate the contextualization and visualization of diverse angles and perspectives to trigger original and feasible solution proposals.

Source: Own creation.

Thus, the four sub-competencies allow transversality of the general competency (complex thinking), which is valuable and necessary in any area, profession, or discipline, as well as in regards to the attention and resolution of situated problems, current as such in social entrepreneurship [20]. Considering this, this paper proposes the possible correlation between social entrepreneurship competencies and complex thinking, which is argued through a test-retest measurement in a social entrepreneurship program.

3. Materials and Methods

As part of an interdisciplinary research group, we developed the SEL4C (Social Entrepreneurship Learning for Complexity) methodology for acquiring and scaling the perception of achieved social entrepreneurship competency. This methodology comprises **nine** practical training activities aimed at developing a process of ideation and construction of a social entrepreneurship project at a basic level. A team of specialists with training in pedagogy and instructional design designed the activities in social entrepreneurship.

When designing the proposed methodology, the team considered the possibility that social entrepreneurship offers the development of other skills. Therefore, each activity has an objective, instructions, and a relationship to the development of the social entrepreneurship competency and its sub-competencies. Each activity also holds the possibility of its participants acquiring and developing skills associated with complex thinking and its

sub-competencies (Table 2) with the intention of guaranteeing the formative process of both competencies at a basic level. It is essential to point out that this possible relationship was proposed at the beginning of the methodological proposal; however, there was no evidence that the process would develop both competencies. The objective was for participants to complete a social entrepreneurship project and perceive themselves as competent change agents.

Table 2. Relationship of activities to developing competencies and sub-competencies of social entrepreneurship and complex thinking.

Activity	Social Entrepreneurship Competency (Sub-Competencies)	Complex Thinking Competency (Sub-Competencies)
1. Triggering questions.	Motivation	Critical Thinking.
2. Lenses of Innovation.	Social Awareness; Empathy; Identification of social and environmental problems.	Critical Thinking.
3. Breaking paradigms.	Perseverance and Resilience; Empathy; Ethical Sense.	Systemic Thinking; Innovative Thinking.
4. Defining your cause	Social implications	Systemic thinking; Critical thinking; Critical thinking
5. Understanding the problem.	Identification of problems; Social implications; Empathy.	Scientific thinking; Critical thinking.
6. Reinventing value propositions.	Courage and social awareness; Social innovation and financial sustainability/Valuing ideas, results, and impacts on the environment and people.	Scientific Thinking; Critical Thinking; Innovative Thinking.
7. Prototyping and Validation.	Tolerance to uncertainty, ambiguity, and stress; Communication and Persuasion; Creativity; Learning and Adaptability.	Scientific Thinking; Systemic Thinking; Critical Thinking; Innovative Thinking.
8. Communicating passion.	Leadership; Mobility of People; Collaborative Work; Resource Management; Economic Literacy.	Systemic Thinking; Critical Thinking; Critical Thinking.
9. Exploration process.	Resource Management; Economic Literacy; Strategic Planning; Collaborative Work; Tolerance of Uncertainty, Ambiguity, and Stress.	Critical Thinking; Critical Thinking; Scientific Thinking; Innovative Thinking.

Along with designing the methodology and evaluating its relevance, we included validated instruments to measure the development of both competencies. Considering the relevance of the perception of achievement, the decision was made to assess its development based on the participants' perceptions. Thus, the Social Entrepreneur Profile instrument [7] was used for measuring the perceived achievement of Social Entrepreneurship competency, and the E-Complexity instrument [21] for measuring the perception of achievement of complex thinking.

- Social Entrepreneurship: The instrument, entitled Profile of the Social Entrepreneur [7], has 24 Likert-scale questions with five rating choices: 1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree. This instrument considers 4 sub-competencies: self-control, leadership, social awareness and value, and social innovation and financial sustainability. For validation, we calculated Cronbach's alpha, which yielded the overall reliability of the instrument to be 0.86. The values for each dimension were as follows: leadership for change, 0.76; social innovation, 0.60; social value, 0.72; and management for change, 0.77.
- Complex thinking: The purpose of the E-Complexity instrument is to measure the participants' perceived mastery of the reasoning-for-complexity competency and its

sub-competencies. It is an instrument validated theoretically and statistically by a team of experts in the field. The means obtained for the criteria evaluated by the experts were as follows: Clarity (3.31), Coherence (3.38), and Relevance (3.54). Based on the theoretical and content validation through expert judgment, it was determined that the eComplexity instrument is highly valid and reliable [21]. The instrument consists of 25 items divided into four sub-competencies: Systemic Thinking, Scientific Thinking, Critical Thinking, and Innovative Thinking. Its implementation is self-applicable, and each item is assessed employing a Likert scale with five ratings: 1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree.

It is important to point out that these instruments have already been implemented in the past, demonstrating their reliability and validity in different educational contexts and environments [22–26].

The implementation process was carried out in three stages:

- Initial diagnosis: Included the implementation of a validated instrument that measured the initial state of the perceived achievement of social entrepreneurship and complex thinking competencies and their sub-competencies.
- Training activities: Encompassed the implementation of the 9 activities designed.
- Closing evaluation: Included the implementation of the diagnostic instrument to evaluate the development of the perceived achievement of both competencies once the intervention was carried out.

It is noteworthy that although the activities allowed for individual or teamwork, the diagnosis and evaluation of the acquisition and development of the perceived achievement of the competencies and their sub-competencies were carried out individually.

3.1. Pilot Implementation

As part of this methodology's validation process, in July 2022, a pilot test was carried out on a small group of students. The objective was to verify that the proposal significantly impacted an experimental group compared to a control group. This pilot study was regulated by the interdisciplinary research group R4C, with the support of the Writing Lab of the Institute for the Future of Education of the Tecnológico de Monterrey, who, because it was an experimental study involving people, suggested that it be limited to a single experimental group of students.

Thus, this pilot study was conducted with a convenience sample of 35 students divided into two groups. The first, composed of 17 students (10 males and 7 females), underwent the pedagogical intervention, i.e., it was the group that carried out the three phases of the implementation process and was called the Experimental Group. In contrast, the second group (Control Group), composed of 18 students (9 men and 9 women), did not receive the social entrepreneurship training methodology, so it only received the initial diagnosis and the closing evaluation. The differentiation between the two groups aimed to identify whether the methodology and the proposed intervention were effectively valid for developing the perception of achievement of both competencies and their sub-competencies.

In general, this pilot test yielded positive results since it showed an increase of 5.9% in the perceived achievement of the social entrepreneurship competency in the interventional group of students, also impacting all its sub-competencies: Self-control (+1.3%), Social Awareness and Value (+5.6%), Social Innovation and Financial Sustainability (+10%) and Leadership (+5.8%).

Regarding the perceived achievement of the Complex Thinking competency, a considerable difference was found between the control and experimental groups. In the overall competency (complex thinking), the control group increased by 1.4% compared to the experimental group, which attained a 5.8% improvement. As for the sub-competencies, the results were similar: Critical Thinking (Control group: no change, Experimental group: +5.5%), Innovative Thinking (Control group: no change, Experimental group: +5.8%), Scientific Thinking (Control group: +3.8%, Experimental group: +9.8%), Systemic Thinking (Control group: +1.1%, Experimental group: +5.8%).

Thus, this pilot study, although yielding limited results due to its small sample, did show a differentiated development, pointing to the need to scale the test in a larger population.

3.2. Validation Process

After the pilot test, the university authorized a new implementation with a larger sample population that was carried out during the August–December 2022 semester. The methodology format was face-to-face, with the support of facilitators who supported the groups involved. This study had 176 participants, divided into 112 students in the experimental receiving the SEL4C methodology and 64 control-group students, where only the development of complex thinking was measured without a social entrepreneurship intervention.

Regarding the data treatment, we performed a multivariate descriptive statistical analysis using the computer software R [27] and Rstudio [28]. The multivariate descriptive analysis consisted mainly of analyzing measures of central tendency (means and standard deviations), complemented with Violin-plots, and correlation analysis, with Principal Component Analysis (PCA), Bi-plot analysis of shape (i.e., $\alpha = 1$) and with a *t*-test to measure the statistical significance in the differences of mean values. In this sense, the means analysis aimed to obtain a reference value of the data set to a given variable. As a complement, the standard deviation allowed us to know how dispersed the values were around the mean value. The violin plot allowed us to observe and explore the data distribution in this context. The violin plot synergistically combines the box-and-whisker plot (i.e., Boxplot) and the empirical kernel density through a smoothed plot into a single visualization that shows the data structure [29]. Likewise, through this analysis, it is possible to observe dispersion, probability density, data behavior patterns, and outliers. The correlation analysis was done through the coefficient of determination (i.e., R^2) to illustrate the correlation between social entrepreneurship competency and complex thinking. In this analysis, a *p*-value of 0.05 was employed, i.e., a 95% confidence interval.

The principal component analysis allowed us to learn more about the students' data behavior in the sub-competencies, avoiding collinearity problems and reducing the data complexity. This was achieved through a set of independent and uncorrelated variables called principal components. These new components are obtained from the original variables capturing the maximum variability. In this sense, there will be a certain number of components corresponding to the number of variables [26,30]. The principal component analysis was complemented with the Biplot graph. It allowed us to observe the students' data behavior with respect to the variables, using the two principal components that capture the maximum data variability [31]. For the analysis, the Biplot of shape (i.e., $\alpha = 1$) was used to favor the plotting of our observations (students). Finally, a statistical significance analysis was performed through the *t*-test on the difference in mean values of the control and experimental groups for complex thinking and social entrepreneurship competencies.

4. Results

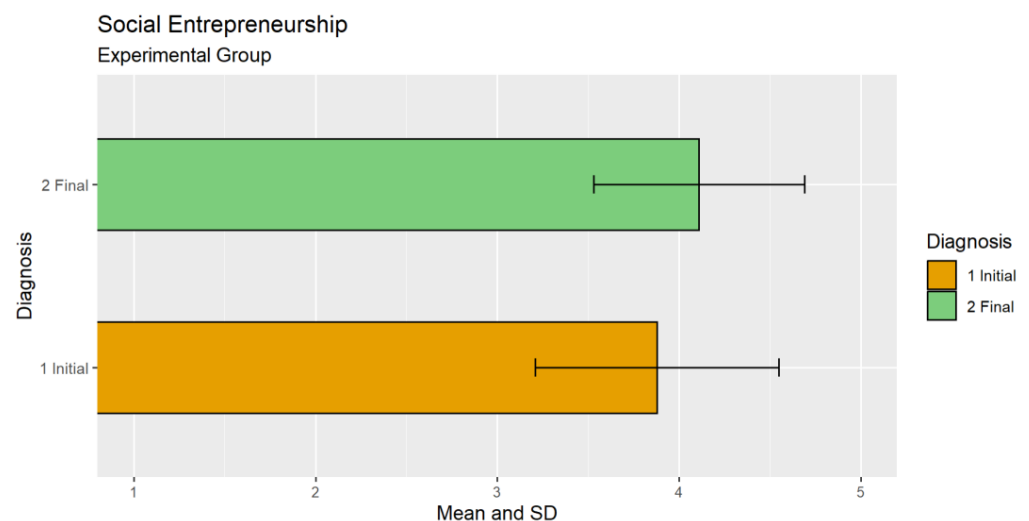
The arithmetic mean was calculated for the experimental-group students' perceived development of social entrepreneurship competency and its sub-competencies. Table 3 shows the analysis of means and standard deviations for each item evaluated. It shows that the students' perception of the development of the social entrepreneurship competency in the initial diagnosis (i.e., before implementing the methodology for acquiring and scaling the competency) was lower than after the activities were carried out. This also occurred for each of the sub-competencies. Table 3 shows that, in the initial diagnosis, the students perceived themselves better in the sub-competency of self-control, followed by awareness and social value (mean values of 4.14 and 3.96, respectively). Social innovation and financial sustainability, and leadership (mean values of 3.50 and 3.90, respectively) had less perceived achievement in the initial stage.

Table 3. Results of the perception of achievement of the Social Entrepreneurship Competency and its sub-competencies of the experimental group (Initial Diagnosis-Final Diagnosis).

	Initial		Final	
	Mean	SD	Mean	SD
Social Entrepreneurship	3.88	0.67	4.11	0.58
Self-control	4.14	0.47	4.29	0.45
Leadership	3.90	0.61	4.15	0.53
Awareness and Social Value	3.96	0.68	4.11	0.63
Social innovation and financial sustainability	3.50	0.73	3.90	0.62

On the other hand, the final diagnosis (i.e., after the methodology for acquiring and scaling the competency was implemented) of the students' perception of the sub-competencies of social entrepreneurship showed an increase. This increase translated into mean values higher than four in all the social entrepreneurship sub-competencies except Social Innovation and Financial Sustainability (mean value of 3.92).

Figure 3 illustrates the perception of social entrepreneurship competency development for the initial and final diagnoses. It illustrates that students perceived themselves better after applying the methodology for scaling social entrepreneurship competency. Likewise, it shows that the standard deviations of the students' perceived social entrepreneurship competency decreased once the methodology was applied.

**Figure 3.** Results of the experimental group's perceived achievement of the Social Entrepreneurship Competency (Initial Diagnosis-Final Diagnosis).

Supplementing Table 3, Figure 4 presents a violin graph of the perceived achievement of the sub-competencies of social entrepreneurship in the experimental group, comparing the initial and final results. The sub-competency with the best-achieved result was self-control, and the one with the lowest was social innovation and financial sustainability. It is relevant to point out that this graph indicates an improvement not only in the means of all the sub-competencies but also in the concentration of responses, which, in the final survey, showed a tendency to higher scale levels.

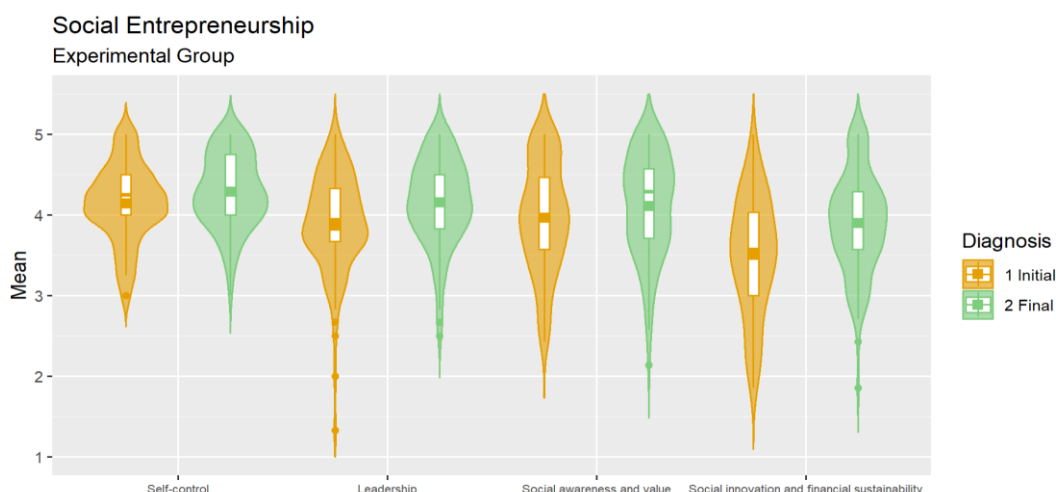


Figure 4. Results by sub-competency of the experimental group's perceived achievement of the Social Entrepreneurship Competency (Initial Diagnosis-Final Diagnosis).

Regarding the analysis of the perceived development of the complex thinking competency and sub-competencies, Table 4 shows the results obtained from the experimental group according to the initial and final diagnosis. The table shows lower mean values in perception in the initial diagnosis than in the final diagnosis. It shows that systemic thinking and critical thinking were the sub-competencies in which the students perceived themselves better once the methodology for scaling up the social entrepreneurship competency was carried out (i.e., mean values of 4.25). In the final diagnosis, students' mean values were higher than four in each sub-competency of complex thinking. In the initial diagnosis, the mean values in two of the four sub-competencies of complex thinking were lower than four (scientific thinking and innovative thinking).

Table 4. Results of perceived achievement of the competency and sub-competencies of complex thinking in the experimental group (Initial Diagnosis-Final Diagnosis).

	Initial		Final	
	Mean	SD	Mean	SD
Complex Thinking	3.95	0.56	4.20	0.52
Systemic Thinking	4.04	0.47	4.25	0.47
Scientific Thinking	3.78	0.61	4.11	0.56
Critical Thinking	4.05	0.53	4.25	0.51
Innovative Thinking	3.93	0.58	4.18	0.54

Figure 5 illustrates the experimental group's perception of the development of complex thinking competency in the initial and final diagnoses. These bars show that the participants perceived themselves with a better mean value once the methodology was applied, confirming our objective. Additionally, the standard deviation in the students' perception decreased in the final survey compared to the initial diagnosis.

As a complement to Table 4, Figure 6 shows a violin graph of the perception of achievement of the experimental group's sub-competencies that comprise the complex thinking competency. It is noticeable that the sub-competencies with the best results were systemic and critical thinking, while the sub-competency with the lowest result was scientific thinking. Noteworthy in this figure is better results in the sub-competencies' means in the final measurement and an improvement in the concentration of responses, with a lower number of outliers than in the initial results.

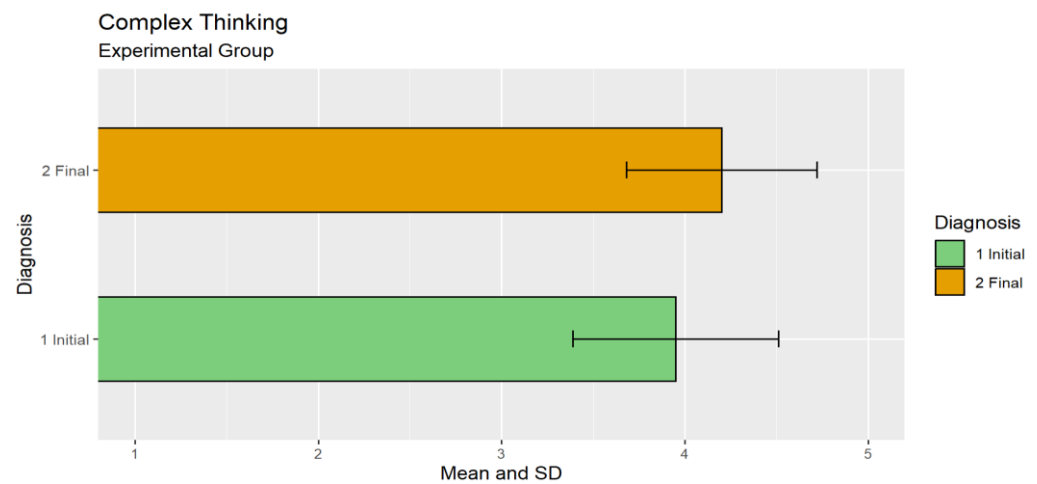


Figure 5. Results of the experimental group’s perception of achievement of the Complex Thinking Competency (Initial Diagnosis-Final Diagnosis).



Figure 6. Results by competency of the experimental group’s perception of achievement of the Complex Thinking Competency (Initial Diagnosis-Final Diagnosis).

The results in Table 5 show a positive correlation between the perception of achievement of social entrepreneurship competency and that of complex thinking in the experimental group of students (R^2 of 0.64). Moreover, they show a higher correlation once the Profile of the Social Entrepreneur instrument was applied (R^2 of 0.74). This allows us to confirm that the methodology impacts the development of skills associated with social entrepreneurship and, in a transversal manner, complex thinking and its sub-competencies.

Table 5. Correlation of development of the perception of achievement of the experimental group’s Social Entrepreneurship and Complex Thinking Competencies (Initial Diagnosis-Final Diagnosis).

Diagnosis	R^2	p -Value
Initial	0.64	3.5×10^{-14}
Final	0.74	2.2×10^{-16}

Figure 7 allows for a better appreciation of the correlation between the perception of achievement of the competencies of social entrepreneurship and complex thinking. It shows that, with the implementation of the methodology, the perceived social entrepreneurship competency and complex thinking competency increased significantly.

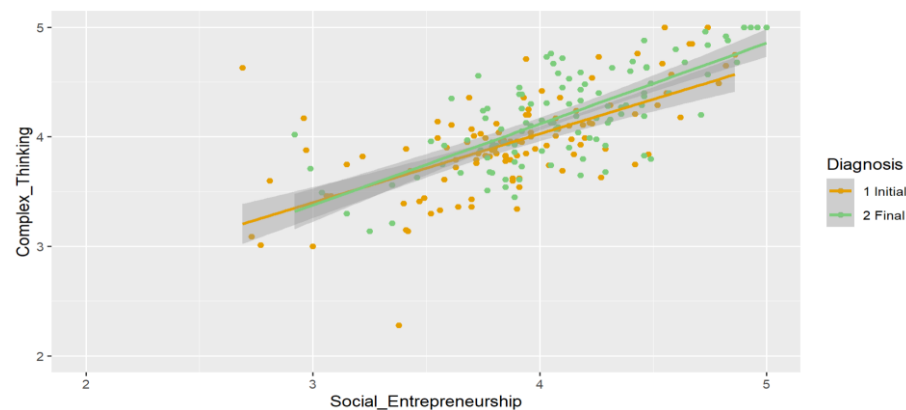


Figure 7. Correlation of the perception of achievement of the experimental group's Social Entrepreneurship and Complex Thinking Competencies (Initial Diagnosis-Final Diagnosis).

Table 6 shows the mean values concerning the perception of the sub-competencies and competency of complex thinking of the control and experimental groups. The table shows an increase in mean values of the complex thinking sub-competencies after implementing the methodology. Note that scientific thinking increased the most: 8.7% in the experimental group and 5% in the control group. In contrast, systemic thinking was the sub-competency with the least improvement, with 5% in the experimental group and 2% in the control group. At the macro level, implementing the methodology improved the perceived achievement of complex thinking by 6% in contrast to the control group, which only increased by 4.5%.

Table 6. Results of the perception of achievement of the Complex Thinking Competency and its sub-competencies of the experimental and control groups (Pre-Post).

Concept	Control Group		Experimental Group	
	Initial Mean	Final Mean	Initial Mean	Final Mean
Complex Thinking	3.70	3.87	3.95	4.20
Systemic Thinking	3.89	3.98	4.04	4.25
Scientific Thinking	3.30	3.47	3.78	4.11
Critical Thinking	3.91	4.04	4.05	4.25
Innovative Thinking	3.85	3.98	3.93	4.18

Figure 8 shows the differences between the perceived development of complex thinking competency in the experimental and control groups, considering the initial and final diagnoses. The experimental group participants not only perceived themselves as more competent at the end of the intervention but also showed more significant development than the control group participants.

Regarding the sub-competencies, Figure 9 presents violin plots comparing the results of the final diagnosis of the experimental and control groups and showing the means and the standard deviation of the responses. As indicated in Table 6, the experimental group had higher means in all the sub-competencies and a better concentration of responses towards the upper part of the scale. This shows a tendency for the participants' perceived achievement to improve once the methodology was applied, noticeable in both the competency and each sub-competency.

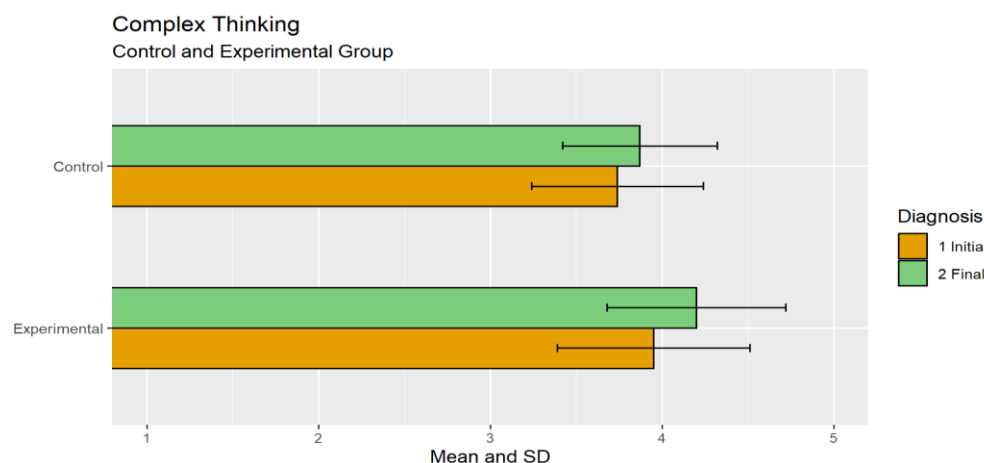


Figure 8. Results of the perception of achievement of the Complex Thinking Competency of the experimental and control groups (Initial Diagnosis-Final Diagnosis).

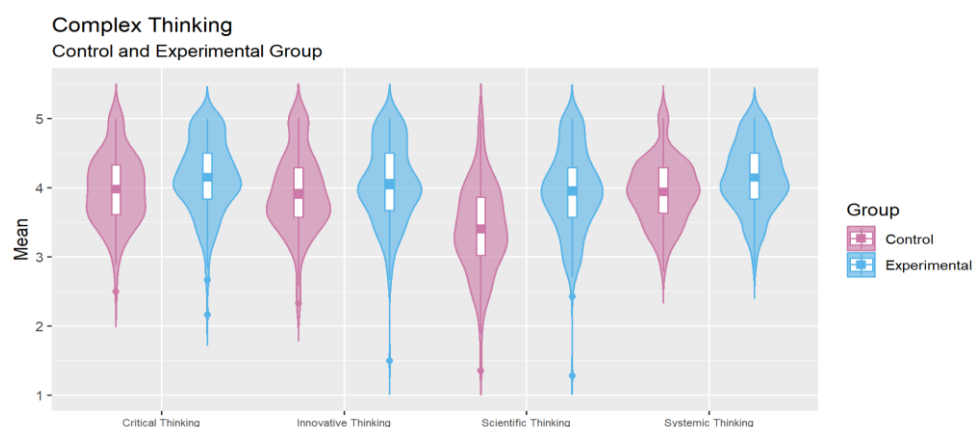


Figure 9. Results of scaling the perception of achievement by sub-competency of Complex Thinking of the experimental and control groups.

Table 7 shows the results of the principal component analysis performed on the perceived achievement of the sub-competencies of complex thinking of the control and experimental groups. Note that the first principal component (PC1) captured 74% of the data variability, and the second principal component (PC2) captured 10% of the variability. That is, PC1 and PC2 captured 84% of the data variability. Likewise, Table 7 shows that PC1 correlates highly with innovative thinking. In this sense, this component would explain the students' ability to solve and attack real problems in a creative, original, and innovative way. On the other hand, PC2 correlates with scientific thinking. This component explains the students' ability to analyze and provide solutions to problems based on methodologies that use validated and standardized processes in the scientific community.

Figure 10 shows the Biplot analysis of shape (i.e., $\alpha = 1$) performed on the perception of achievement of the sub-competencies of complex thinking of the control and experimental groups. Figure 10 shows that the experimental group students perceived themselves best in developing each sub-competency. Some students stand out in scientific, innovative, and systemic thinking. On the other hand, the control group students had the opposite behavior in developing the competencies. In other words, the students in the control group did not perceive themselves as having developed the sub-competencies. Except for a few students who stood out in developing critical thinking, the general behavior of the control group regarding the sub-competencies was deficient.

Table 7. Principal component analysis matrix. Analysis of the perceived achievement of the sub-competencies of complex thinking (Control and experimental groups).

	PC1	PC2	PC3	PC4
Subc. Systemic Thinking	0.49	−0.19	0.83	0.16
Subc. Scientific Thinking	0.48	0.79	−0.03	−0.35
Subc. Critical Thinking	0.50	−0.57	−0.32	−0.56
Subc. Innovative Thinking	0.51	−0.01	−0.45	0.72
Standard Deviation	1.72	0.63	0.60	0.52
Proportion of Variance	0.74	0.10	0.09	0.06
Cumulative Proportion	0.74	0.84	0.93	1.00

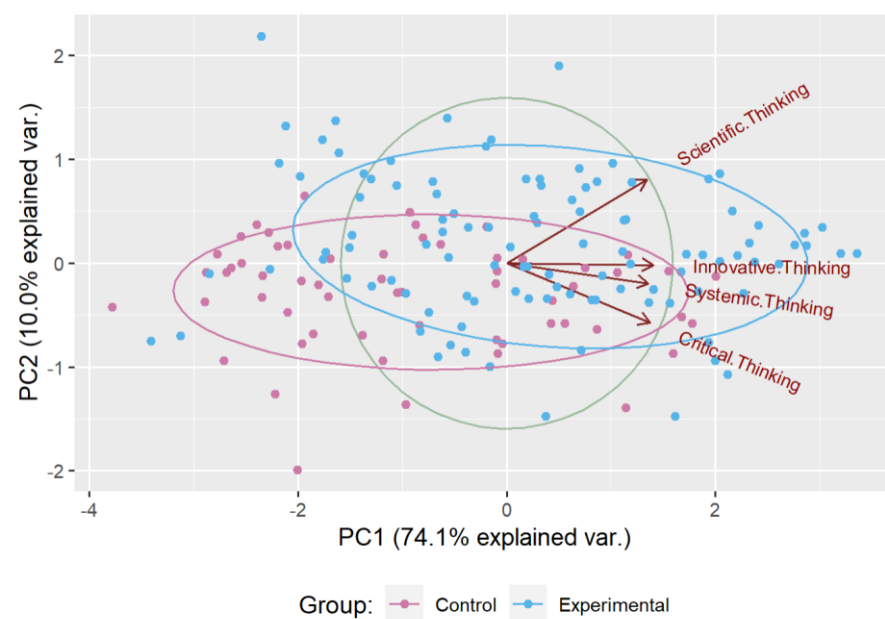
**Figure 10.** Biplot of final results. Comparison between the experimental and control group's final results in the perception of achievement of the complex thinking competency.

Table 8 shows the analysis of the significant differences in the mean values of perceived complex thinking achievement between the experimental and control groups. The table shows significant differences between the mean values of the two groups.

Table 8. Results of significant differences between control and experimental groups in the perception of achievement of complex thinking competency (t student).

	t	df	p-Value
Complex Thinking (Control and Experimental group)	−4.7093	130.36	6.272×10^{-6}

5. Results Discussion

As seen in the results (Table 3 and Figure 3), it can be confirmed that the SEL4C methodology proposed in this study is indeed valid for scaling the perception of achievement of social entrepreneurship competency and its sub-competencies. In general, the perceived achievement of the social entrepreneurship competency significantly improved (Initial: 3.88, Final: 4.11), proportional to what happened in the pilot test (Initial: 4.20, Final: 4.45). In both cases, the increase was 6% overall. Thus, the methodology is valid

and constant in improving the perceived achievement of this competency, regardless of the applied population.

Upward scaling occurred in all the sub-competencies: Self-control (Initial: 4.14, Final: 4.29), Awareness and Social Value (Initial: 3.96, Final: 4.11), Leadership (Initial: 3.90, Final: 4.15) and Social Innovation and Financial Sustainability (Initial: 3.50, Final: 3.90). This can be seen not only in the means, but also in the standard deviations, which had more concentrated responses at higher levels of the scale, both in the overall result (Figure 3) and in the sub-competencies (Figure 4).

In the pilot test, this methodology focused on demonstrating how intervention in social entrepreneurship can impact the development of perceived achievement of the complex thinking competency; therefore, the result in the social entrepreneurship competency is valuable. What is truly innovative is the possible impact on the perceived achievement of the complex thinking competency and the correlation between the two. In this sense, Table 4 presents the results of the experimental group's complex thinking competency and sub-competencies.

As can be seen, the complex thinking competency significantly increased its perceived achievement (Initial: 3.95, Final: 4.20), which was proportional to the increase recorded in the pilot test (Initial: 4.31, Final: 4.56). In both cases, the 6% increase showed the validity and consistency of the methodology regarding this second competency (Figure 5). As for its sub-competencies, all increased: Systemic Thinking (Initial: 4.04, Final: 4.25), Scientific Thinking (Initial: 3.78, Final: 4.11), Critical Thinking (Initial: 4.25, Final: 4.05), and Innovative Thinking (Initial: 3.93, Final: 4.18). This can be seen in the means and the standard deviation, which had more concentrated responses at higher scale levels, both in the overall competency (Figure 5) and its sub-competencies (Figure 6).

Thus, sufficient information confirms that the SEL4C methodology impacts the perceived achievement of both competencies and their sub-competencies, with a positive correlation index of 0.74 (Table 5 and Figure 7), similar to the pilot test (0.75). At this point, it is possible to determine concordance in all the results between this study and the pilot test.

Now, seeking to deepen these data and to identify the impact of the methodology more clearly, we present the comparative results between the experimental and control groups. Considering that the control group did not carry out a social entrepreneurship project, only the results of the Complex Thinking competency are presented, which are truly significant.

As can be seen in Table 6, the experimental group in which the methodology was implemented showed considerable improvement in the means of the perceived achievement of the Complex Thinking competency (Initial: 3.95, Final: 4.20) compared to the control group (Initial: 3.70, Final: 3.87) (Figure 8). While the experimental group had a 6.3% improvement, the control group improved by 4.6% in their overall score. It is important to note that although the initial value varied between the two groups, the focus was on the level of improvement and not so much on the values achieved.

Similarly, the sub-competencies had significant differences between both groups (Table 6). As corroborated by Figure 9, the experimental group perceived themselves more highly. In all sub-competencies, more significant improvement can be seen in the experimental group: Systemic Thinking (Experimental: +5%, Control: +2.3%), Scientific Thinking (Experimental: +8.7%, Control: +5%), Critical Thinking (Experimental: +5%, Control: +3.3%), Innovative Thinking (Experimental: +6%, Control: +3.3%). As the violin plot in Figure 9 shows, the best results are shown in their upper means and the standard deviation, which yields a higher concentration of responses in higher parts of the scale.

A matrix of principal component analysis (Table 7) and a Biplot of the results of both groups corroborate this difference. As can be seen in this graph, there is a greater concentration of positive responses in the experimental group than in the control group. While the reliability ellipse of the experimental group shows a positive trend, that of the control group deviates oppositely. To corroborate this difference, we performed a reliability

analysis of the results of both groups (Table 8), confirming that statistically significant differences exist.

These results validated the positive impact of applying the SEL4C methodology, demonstrating that the proposed social entrepreneurship intervention impacts the perceived achievement of these skills and is also an efficient and reliable alternative for developing complex thinking and its sub-competencies. These findings demonstrate that although these competencies can be developed naturally, it is valuable to design pedagogical interventions that allow a greater scaling, achieving not only better results in their level of perception, but also a faster and more efficient development.

6. Conclusions

A relevant feature in forming competencies is how they tend to interact, considering that developing certain skills can simultaneously influence the acquisition and scaling of others. This is what motivates the approach of the methodology presented here, which recognizes that the development of a social entrepreneurship project not only impacts the acquisition of skills naturally associated with these types of proposals but also, in parallel, develops other transversal competencies, such as, in this case, complex thinking, and its sub-competencies.

In this sense, SEL4C methodology derives from the hypothesis that social entrepreneurship competency, due to its interdisciplinary and transversal characteristics, can impact the perceived achievement of complex thinking and its sub-competencies. Therefore, it was worth developing training activities that, when implemented in a classroom, would allow the acquisition and scaling of both skills and improve the students' perception. This methodology is based on the principle that before being assessed as competent, the student must perceive himself as such.

Thus, this article presents the results of the validation of SEL4C methodology, corroborating its validity per the results of the pilot test previously carried out in a smaller population. Among the findings, it is possible to go beyond the proposed hypothesis because the methodology achieved more considerable scaling in the perceived achievement of complex thinking and its sub-competencies than the control group. It also yielded similar results to the pilot study, demonstrating its constant validity regardless of the number of participants, having the same impact on both large and small groups.

These results are academically valuable, as they show the opportunity for academic interventions to impact the development of two or more competencies. They also reveal broad areas of practical implementation for universities with entrepreneurship programs and other institutions that work directly with social entrepreneurs. This methodology spotlights the formative relevance of social entrepreneurship beyond economic or business impact, showing itself as a pedagogical tool for forming other competencies.

A limitation of this study is that its implementation is limited to a single institution and a single context, so it is recognized that a broader application is still needed that considers participants from different institutions and countries to see how the SEL4C methodology behaves in other contexts. It is important to point out that this has already been approved by the research group and is currently being carried out. Even so, it can be concluded that this article fulfills its objective by providing results that validate the relevance of adopting this methodology both for training in social entrepreneurship and for the development of complex thinking.

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