



Impact of the Development of Critical Thinking Skills and Academic Development of Vulnerable Students during Confinement due to COVID-19

Impact of the development of critical thinking skills and academic development of vulnerable students

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ABSTRACT

This study examines the impact of confinement on critical thinking (CT) skills in vulnerable students pursuing careers in nutrition, nursing, and physical therapy and rehabilitation at a private educational institution on the Atlantic Coast in Mexico. In the situation of confinement is important use the CT skills to improve the development of the students in our institution. The original research comes from a mixed two-stage, quasi-experimental sequential study. The sample is non-randomized for the convenience of thirty-seven students, who comprise nineteen women and eighteen men, aged 20 to 24. In a first stage of the study twenty-six teachers are trained in CT, all showing an increase in the disposition questionnaire to the CT. Educational intervention is conducted in Google Classroom through the creation of a research project. The main results show a positive impact on the control group on interpretation skills ($X_{pre} = 1.3$ to $X_{pos} = 2$), analysis ($X_{pre} = 1.3$ to $X_{pos} = 1.8$) and evaluation ($X_{pre} = 1.2$ to $X_{pos} = 1.9$) of the CT, with an average effect size of 1.5 from the pretest-to-post-test evaluation. At CT development levels, results show a positive large effect size (1.3). The project spurred a meaningful change in CT in the students of the experimental group and led to better personal performance. The final work, product of the educational intervention, facilitated viable ideas on how to be more effective in their approach to research for thesis. In conclusion the confinement did not affect to the students in the experimental group. With this all the students continued in the university, there was no desertion in the experimental group, the control group had a desertion of four students.

CCS CONCEPTS

• General and reference; • Document types; • General conference proceedings;

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KEYWORDS

Critical thinking (CT), interpretation, analysis, evaluation, educational innovation, health area

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1 INTRODUCTION

Improving the teaching-learning process is the primary responsibility of educational institutions in the development of their students (Din, 2020). This is the basis of the present study. Bezanilla et al (2018) and Uribe et al (2017) explain that critical thinking (CT) is a skill that must be taught, since current problems are so complex that they can only be resolved through analysis and critical thinking (Paul, 2009, quoted in Uribe et al., 2017). At the institution, this educational innovation project was to enrich the learning and CT skills of students with selected higher education degrees in health, such as nutrition, nursing, and physical therapy and rehabilitation.

The General Law on Higher Education in Mexico (Secretariat of Public Education, 2019) states that CT training is a function of the new Mexican school (Chapter One). The development of the CT within schools is noted in Chapter Three. Chapter Four defines the CT as part of a comprehensive orientation to education: “the ability to identify, analyze, question, and value phenomena, information, actions and ideas, as well as to take a position on facts and processes to solve different problems of reality.” Article 108 mentions oversight of the development of the CT in students, as does Article 126.

This research is intended to introduce CT through an infusion modality as a skill of students in line with what was reported by Rodríguez (2018) and Facione (2020) in higher education. This modality is included within one of the subjects in each of the higher education degrees. Educational intervention impacts three CT skills (Facione, 1990 a and b, 2020): interpretation (the ability to break down an idea in its parts); analysis (identifying the disaggregated parts and their relevance to the statement of the idea); and evaluation (identifying the idea to make it true). This also includes observing the impact of the intervention on students’ academic performance (Facione, 1990 a and b, 2020).

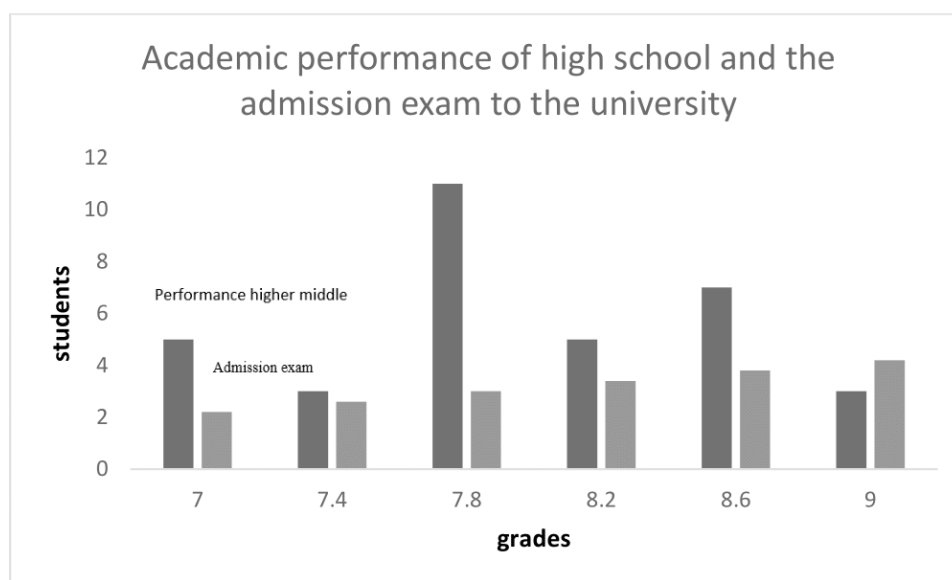


Figure 1: High school final grades (strong grey) vs. admission test grades (shaded grey) of the students in the sample of this work in the university

In the state and city where the research was done, the economy depends on agricultural activities and there is some industrial and technological activity. The city is the capital of the state, so organizations and communities subsist from the presence of state-related jobs (secretariats, courts, etc.), which is the basis of the state public university (source: <http://cuentame.inegi.org.mx/monografias/informacion/ver/>). Nonetheless, there are many private universities that offer alternatives to students who cannot access the public university. The average schooling rate in the state is 15 years, with an academic rating of 8.2 (the national average is 9.2). For persons 15 years of age or older, 9.2% have no schooling, 55.2% have completed basic education, 19.7% have higher-middle education, 15.6% have tertiary qualifications, and 0.3% did not specify (INEGI, 2017). This gives an idea of the kind of students are included in this research.

None of the students in this study had been admitted to the prestigious public university. The university entrance exam requires a passing grade of 55%. All students came from dysfunctional families, hence the categorization as “vulnerable.” This statement is important to our determination to teach CT skills, to improve their social context (Facione, 2020). Given this the vulnerability is defined as “the quality or state of being exposed to the possibility of being attacked or harmed, either physically or emotionally. In one sense, vulnerability is characteristic of the human condition” (Clark and Preto, 2018), in our context this definition is accomplished.

Figure 1 shows how the academic performance of the higher-middle education of the research students differs from the results of the college admission exam (data obtained in the university files of each student). This shows an academic weakness and deficiency that may explain students’ failure in the public education system. However, little CT is inferred by the inability to solve the problems in this exam.

Further analysis, of the files of the students both, the experimental and the control group, showed that thirty of the students come from broken families, 16 (44%) without a parent, raised by family members and 14 (38%) with one parent absent. This absence was due to divorce or disappearance, either of the father or mother or both.

Then, the intention is to design an educational intervention to improve the condition of these students. While the initial focus was on their academic skills and competencies (Erikson & Erikson, 2019), it is expected that this will also help them professionally, and in their social abilities. Roor and Burkander (2020) and Ristanto et al. (2020) demonstrated that it is possible to teach CT to vulnerable populations through critical reading and immersion (including CT as a teaching method within the different subjects of the curriculum) of CT in diverse groups and types of students. The evaluations, prepared by the authors mentioned (Roor and Burkander, 2020, and Ristanto et al., 2020), demonstrated increased CT skills and improvements in the social performance of students.

Different scientific studies (Susetyarini and Fauzi, 2020; Bezanilla et al., 2018; Din, 2020; and Fandiño, 2021) find that students’ academic performance improves with CT teaching. Dring (2019), recounts how CT skills are important for medical teaching through problem-based learning. These studies are the basis of the design of this educational intervention for improving the academic expectations and prospects of vulnerable students.

In our context, due to the confinement caused by the Covid-19 pandemic, classes had to be held online in the university. It was necessary to redesign and adapt all educational programs to online classes. There was a radical change in university education with increased use of videoconferences, ICT, technology-adapted evaluation systems, integrating manuals to clarify the teaching

and virtual evaluation process, and training for both teachers and students in using these technologies.

2 CONCEPTUAL FRAMEWORK

To introduce the concepts that are used in this work, the next paragraphs are presented.

2.1 Critical thinking

CT is defined as the ability to interpret, organize, and decode information, looking for a meaning to the problem and clarifying it, analyzing information by examining ideas, identifying arguments, and arriving at an assessment. Apart from cognitive capabilities, CT is rooted in attitudes and values that are geared toward solving problems and adapting to circumstances, with the observation and analysis of information, the search for logical and ethical inferences, the determination of implications and their consequences, leading to an effective and empathetic communication of results (based on Facione, 1990 a and b, Abrami et al., 2018).

The structure and systematization of the CT in a subject, according to the skills proposed by Facione (2020), is done in the following manner:

- Interpretation. The subject can comprehend or express the meaning or significance of a wide variety of experiences, situations, data, events, judgments, conveniences, beliefs, rules, procedures, or criteria. The type of assessment in health, suggested by Facione (2020), is the search for a problem relevant to discipline.
- Analysis. The subject can identify the inferential, intentional, and current interrelationships, between assertions, problems, concepts, descriptions, or other forms of representation that are intended to express beliefs, judgments, experiences, reasons, information, or opinions. This is done through a theoretical and methodological analysis with search for a bibliography relevant to the problem.
- Evaluation. The subject achieves and values the credibility of assertions or other communications that are part of the description of an experience, situation, judgment, belief, or opinion; and evaluates the logical coherence of current or intentional inferential interrelationships of judgments, descriptions, problems, or other forms of presentation of an idea. Evaluation is done by establishing a feasible and reliable solution proposal to the problem.

Three additional Facione (2020) are inference, explanation, and self-regulation. However, due to the vulnerability of the students and the brief time of the educational intervention, it was decided to develop the first three skills only.

Nelson-Hurwitz and Buchtal (2018) explain how CT is integrated as a tool of deliberative pedagogy to inculcate skills, interpretation, analysis, and evaluation in health education programs and health curricula. In Table 1, is shown how different authors listed along with their findings, the evaluation tools used, and the different CT skills evaluated in each study. This was the basis of the feasibility of the present study.

In Mexico, CT has been included, with some controversy, as an additional subject to the processing plans of many educational institutions, rather than as an infusion or immersion—a situation

that has only recently begun to change (Rodriguez, 2018; Patiño, 2018; Lopez, 2018).

This educational intervention sought to conduct teaching-learning strategies that improve the CT and develop these skills in vulnerable students. Teacher training is included in the intervention. The study addressed the following research question:

How does CT interpretation, analysis, and evaluation impact students that are in nursing, nutrition, and rehabilitation degrees at an educational institution in the northeast of the country under conditions of vulnerability. During confinement.

3 METHODOLOGY

The research is a mixed sequential study (Stevenson, 2020) consisting of the following stages:

The first stage is **qualitative**. The questionnaires are validated utilizing Inter-judge's methodology (the CT Skills and the CT development level questionnaires) with content validation. This methodology a panel of experts in the field to evaluate the information and determine whether the instrument is reliable and has valid content, according to its criteria and solvency (Cremades, 2017). With this study, CT experts analyzed and validated the questionnaires, with at least two of the three judges having to be in accord for a question to be retained.

In the second stage, a quasi-experimental *quantitative*-correlational study was conducted (Stevenson, 2020; Bazeley, 2019) to gauge the impact of educational intervention on the development of CT skills by vulnerable students. The results of the questionnaires are statistically analyzed to provide an empirical measure of the skills and levels of development of the students' CT, along with their ability to improve academic performance.

Teachers are pre-trained in administering the CT, with a quantitative instrument also used to assess their disposition.

3.1 Participants

The sample comprised thirty-seven students, chosen non-randomly for convenience. All students were from the final semester of the bachelor's degree program in nutrition, nursing, and physical therapy and rehabilitation. The thirty-seven students in the sample come from different higher-middle schools, all state-run, with four from the locality.

Students in the experimental group (18 students) began their thesis for obtaining their academic degree. No student said that they had been previously instructed or trained in CT.

The control group (19 students) is from the previous immediate semester for each bachelor's degree. The experimental group (18 students) of the last semesters of each career was designated as experimental since they will soon finish their studies

3.2 University Educational Model

The institution's education model of the institution is a competency-based one in which the student learns to solve problems through practical instruction and in real environments. Despite the merits of this type of teaching-learning, it is still necessary to place greater emphasis on CT. The CT methodology is not immersed, nor are the teachers trained in CT or infusion or immersion methods.

Table 1: CT evaluation models

Author	Country	Findings in research	Evaluation instrument	CT skills evaluated
Din, 2020	Pakistan	Study shows how the CT improves the skills of students from other languages, getting that, despite having a highly positive response to the CT, this is not reflected in an improvement in reading and critical reasoning.	<i>Critical thinking</i> inventory, critical thinking <i>test</i> , and critical reading <i>test</i> . The latter are part of the Watson-Glaser CT tests (WCGTA, 2002)	The skills evaluated, the analysis, the interpretation, evaluation, inference, explanation of texts and readings.
Susetyarini and Fauzi (2019)	Indonesia	Conduct a review of articles published in your country from 2016 to 2018	CT evaluation with multivariate tests, with t-test and statistics with computer programs. Tests with R and D were scarce and experimental studies were quasi-experimental studies. Qualitative ones were scarce.	It is not specified which skills were taught.
Faramarzi and Kahfri (2019)	Iran	Their study shows the CT influences medical education, linking CT performance with socio-emotional situations such as self-esteem, positive affection, and stress management. Finding a positive relationship between the CT and an adequate level of these socio-emotional situations.	They evaluated the CT in this study with the California CT Skills Test, the Positive Affect Scheme, the Ahvaz Psychological Difficulty Inventory, and the Rosemberg Scale of Self-Esteem.	Analysis, interpretation, evaluation, inference, self-esteem, and self-efficacy
Becirovic et al. (2019)	Bosnia and Herzegovina	They research 279 students, Bosnians and Turks, the CT level, and its impact on education. Finding that nationality and the degree of studies impacts the level of CT use, not so in terms of gender. Therefore, they suggest a review of the school curriculum to improve the level of the CT.	With questionnaire evaluating 4 CT situations, inhibiting the CT, CT applications, class activities that prevent the CT and teacher support for CT development. Statistics were done through factor analysis.	Self-efficacy and self-direction with the CT, both components of self-regulation.
Zayapragassarazan y Chacko (2019)	India	They establish the CT as paramount in teaching in medicine. Descriptive cross-sectional study on CT skills and gap with attitude toward CT.	Watson-Glasner CT test and a self-assessment format of CT layouts.	Interpretation, inference, and evaluation.
Bezanilla et al. (2017)	Latin America and Spain	They survey 320 teachers, who consider the CT especially important in higher education; if it is possible to develop the CT in its subjects and you can work the development of the CT. The authors define that CT teaching is important.	CT skills teaching assessment scheme designed by authors.	analysis, evaluation, inference, explanation and self-regulation with self-reflection and self-awareness, among other skills.
Hindawi et al. (2020)	Iran	They recount CT research on medical students in Iran	Meta-analysis of studies	CT skills of different authors in different research

Source: own elaboration.

Table 2: Characteristics and averages of the students to be included in the study (pre-study quarter).

Degree	Students	Sex	Age	Previous academic qualification
Rehabilitation VI GC	4	M=1 F=3	21	8.1
Rehabilitation VIII GE	14	M=9 F=5	24	8.1
Infirmarium VI GC	8	M=3 F=5	22	7.8
Infirmarium VIII GE	2	M=0 F=2	22	7.9
Nutrition VI GE	2	M=1 F=1	23	8.7
Nutrition IV GC	7	M=2 F=4	20	7.7

Source: Own elaboration (GE-experimental group, GC-control group)

Evaluations are done in a formative way in the classroom, by individual teachers who determine their rubrics. They can use class participation, homework presentation, or evidence portfolios that are presented to the academic secretariat at the end of the semester.

Evaluations are conducted by percentages with 50% attendance and formative evaluation and 50% of the summary assessments, which are two partial and one final. At the end of the quarter, all partial results are averaged with the final on a 0-10 scale.

3.3 Teacher Training

The CTteacher training process was initiated using Facione's description of skills and sub-skills (2020). Facione (2020) offers the CT disposition questionnaire to explore attitudes toward CT, especially in teachers, an instrument with validity and reliability confirmed by a panel of experts described in the original paper.

The inter-judge's methodology was used to verify the validity and reliability of this instrument in our context. The judges translated the content of the questionnaire from English to Spanish. This methodology consists of providing the information to a panel of experts in the field, who validate the content (Cremades, 2017). This is done by three CT experts, teachers with over ten years' educational experience in teaching and research in CT with two institutions, public and private, that are among the most prestigious in the country.

Teacher training was conducted through Google Classroom where teachers looked at videos where each skill and sub-skill of CT was explained, with a blog for questions or comments regarding the course. The videos were 10 to 15 minutes long, created by the authors, and given over seven days.

3.4 Educational Intervention

The educational intervention focused on instilling selected CT skills— interpretation, analysis, and evaluation—in the students from the experimental group. The student control group had no change or disposition with respect to CT in any classes.

The intervention, which involved application of each CT skill, took place over three months for 10 to 15 minutes daily, through

online activities on the Google Classroom (GC) platform. Students were building a research project where they needed to pose a valid, feasible, and useful research question, as well as justify the research for their discipline, be it nursing, nutrition, or physical therapy and rehabilitation.

Every month a CT skill was taught with its sub-skills (one per week) with the activities designed to be complemented based on rubrics taken from *The Holistic Guide to Evaluate Critical Thinking* (Facione, 2020), along with specific rubrics for the students' writing. This rubric can be reviewed in the following Drive <https://1drv.ms/w/s!ArAHQO9g1yMHGs9nfJmPbQMHC7Lzg?e=BnTWGb>.

3.5 Instruments

3.5.1 Questionnaire for Teachers, Disposition Toward the CT. This Facione questionnaire (2020) was validated by the panel of experts listed in the document. It has a Likert scale consisting of twenty questions. Odd questions answered IF are assigned five points and are NOT 0 points; even questions are graded with five points for each NO and each SI is zero points. Thus, you can get a disposition toward the reluctant CT, by getting fifty or fewer points, ambivalent, from 51 to 69 points and positive with seventy or more points. This scale is located on Google Drive in the following Spanish-language league: <https://1drv.ms/w/s!ArAHQO9g1yMHGs4uHHT7omnYlGHN1g?e=oScb4F>

3.5.2 The Holistic Guide to Evaluating Critical Thinking. The Holistic Guide describes the characteristics of the skills and sub- CT skills with the first three taken by the level of difficulty that impacts teaching and its integration: interpretation, analysis, and evaluation. Facione (2020). The evaluation scale is constructed by assigning a value to each response following the Holistic Guide to Evaluating CT (Facione, 2020) and is assigned a numerical value 1 if there is a strong, acceptable (3), unacceptable (2) or weak (1) skill. The validity and reliability of these instruments is described in Facione (2020) by the panel of experts who define kappa statistics as the instrument exercised for this aspect.

Table 3: Design of the educational intervention (GC'Google Classroom')

Period	Ability to develop	Learning activity	Learning evidence	Evaluation	Resources
First month of the quarter	Interpretation:	Identify a relevant problem in the discipline. Conduct an essay on what that problem means and its relevance in its resolution	Written presentation of the problem on paper and on the Platform. Perform the test in GC	Heading on interpretation of the Holistic Guide	Humans: Qualified teacher on CT, assistant Materials: Laptop, projector, and classroom
WEEK 1	Categorization of the research problem	Perform the percussion of the discipline-relevant problem synchronously and later the GC platform	Filing the problem with proper categorization in accordance with the Holistic Guide on the GC platform	Compliance with the Holistic Guide	Same
WEEK 2	Decoding meanings in the research problem	Perform a written essay on the GC platform and subsequent discussion in virtual class	Same criterion	Compliance with the Holistic Guide	Same
WEEK 3	Defining meanings of the research problem	In virtual class, the different meanings of each problem are defined for the subject matter in question	Glossary of terms on the GC platform	Same compliance	Same
WEEK 4	Final interpretation of the research problem	Perform the problem re-editing with bibliographic support	Formal presentation of the problem with research question and hypothesis for thesis	Same compliance	Same instruments
Second month of the quarter	Analysis	Realizes research for information relevant to the problem. Make a mental map of the problem. Evaluate the mental map arguments based on the detected bibliography.	Presentation in writing and on the platform of bibliographic references. Presentation of mental map in physical. Evaluation of arguments on the platform.	Rubrics on analysis, presentation of bibliography in APA format	Same instruments
WEEK 5	Examine ideas	Search for the bibliography relevant to the topic	Presentation of the bibliographic sheet on the platform	Presentation of the bibliography in the APA format with analysis of this	Same
WEEK 6	Detection of arguments in ideas	Mental map of the problem	Presentation of the mental map, in physical form and on the platform	Heading on mental map development	Same
WEEK 7 and 8	Assessing the arguments of ideas	Evaluate the arguments with the mental map and the detected bibliography	Discussion in face-to-face class and platform	Rubric on analysis	Same
Third month of the quarter	Evaluation: Evaluate differences in arguments. Evaluate arguments.	Detecting the differences between the arguments presented Re-evaluating arguments with new literature	Presentation in physical and platform of the differences detected. Infographic with evaluation	Evaluation with the heading of the Holistic Guide and the CT Evaluation Rubric	Same

Table 3: (Continued)

Period	Ability to develop	Learning activity	Learning evidence	Evaluation	Resources
WEEK 9 and 10	Assess differences in final arguments	In the virtual class detect the differences between the arguments presented and, on the platform, present these arguments in writing	List of arguments detected and their differences on the platform	Same	Same
WEEK 11 AND 12	Evaluate the final arguments	Perform an infographic with the evaluation of the arguments	Presentation of infographics on the platform	Same	Same
Fourth month of the quarter	Final review	All skills with their sub-skills	Post-test presentation	Proposed tests	Same

Source: Own elaboration.

Table 4: Cronbach Alpha from the CT Skills questionnaire applied to the control and experimental groups before and after the educational intervention, (e, experimental, c. control).

	Control group or experimental group	No items	Alfa de Cronbach
CT Skills Questionnaire	Experimental interpretation	5	0.652
	Experimental analysis	5	0.441
	Experimental evaluation	5	0.473
	Interpretation control	5	0.528
	Analysis control	5	0.333
	Evaluation control	5	0.618

Source: Own elaboration,

3.5.3 CT Skills Questionnaire. The questionnaire is adapted to our context from Carrasco (2018), with respect to the structure of the questions originally presented, in the texts, so that only the question fragments that evaluate interpretation, analysis and evaluation are utilized (Facione 2020 and Carrasco, 2018). These questionnaires were evaluated by three CT experts (profile previously given) with the inter-judge's methodology.

Both Facione's communication CT advisory group (2020) and the research instruments have been applied in more than one hundred countries. The CT skills quiz and holistic lesson can be viewed in Spanish in the following league: <https://1drv.ms/w/s!ArAHQO9g1yMHGs4x4ziZGNcIMmRMFg?e=bhfy4j>

The reliability of the instrument was obtained through its Cronbach alpha. In general, high reliability was obtained, except in the analysis ability, in both groups, where it is inferred that the weakness of the responses is the cause of this qualifier (see Table 4).

3.5.4 CT Development Levels Questionnaire. This questionnaire explores CT interpretation, analysis, and evaluation levels (Facione, 2020) across a Likert scale with the assignment of a value for each positive or negative question, which is summed to give an appreciation of the level of CT skill development. This evaluation is taken from the work of Marciales (2003) but contextualized to this research, taking only the questions that

evaluate interpretation, analysis, and evaluation with the rating scale adapted for this study. The questionnaire is located on Google Drive in the following league: <https://1drv.ms/w/s!ArAHQO9g1yMHGs5K8KZoBPGEy5vQog?e=bmhav0>

These instruments were validated by CT experts, as previously noted, through the Inter-judge's methodology, its reliability obtained by Cronbach's alpha. Table 5 shows high reliability for this instrument.

3.5.5 Data analysis. We used the SPSS program to perform much of the quantitative data analysis, to find the significant statistical difference between the pretest and the post-test (Grotenhuis and Matthijssen, 2016) of the teachers, to analyze the skills of the CT and the variables between the CT experimental group and the control group before and after the intervention and for academic performance using the Student t-test (Bunterm, et al. 2012).

4 RESULTS AND DISCUSSION

4.1 Teacher Training Results

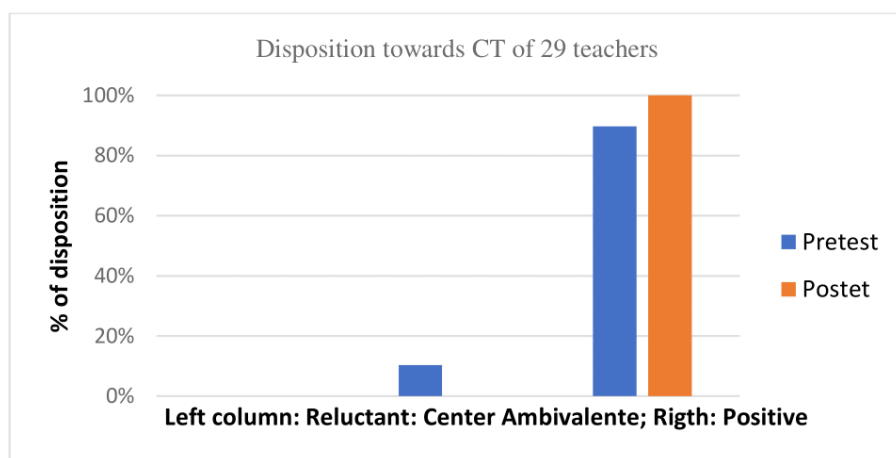
The results of the teacher training are presented in Figure 2

The result in the post-test shows that twenty-six of the teachers changed their disposition toward the CT from negative to positive.

Table 5: Cronbach Alpha the CT development levels questionnaire applied to the control and experimental groups before and after the educational intervention, (e, experimental, c. control).

	Control group or experimental group	No items	Alfa de Cronbach
CT Development Levels Questionnaire	Experimental interpretation	11	0.860
	analysis	6	0.610
	evaluation	8	0.920
	Interpretation control	11	0.770
	Analysis control	6	0.550
	Evaluation control	8	0.880

Source: Own elaboration.

**Figure 2: Result obtained from the application of the self-qualification form (pretest and posttest). Applied to twenty-nine professors at the University. Source: own elaboration.****Table 6: Descriptive analysis of tests applied to teachers.**

	Media	n	Deviation std.	Coef. variation
Pretest	79.2	29	7.005	8.76%
Post-test	86.7	29	5.239	6.05%

Source: Own elaboration.

Table 7: Student t-test for related samples of the pretest and posttest differences of the critical thinking variable (DF-degrees of freedom).

Student's t	7.1344
DF	28
Bilateral t	0.000

Source: own elaboration

It is observed (Table 6) that the average valuation increased from 79.2 (pretest) to 86.7 (post-test), with a decrease in variability being observed, reflected in the coefficient of variation, which goes from 8.76% in the previous phase to 6.04% in the post-test phase.

Table 7 shows statistically significant differences in pretest measurements in the CT study variable. That is, there are differences in the variable analyzed after the intervention.

Given the results, the decision was made to reject or accept the statistical hypothesis, such as the probability obtained from Student's t that the value of p is less than the significance level α ($0.000 < 0.05$), i.e., a highly positive value.

CT training for teachers increases the development of skills, skills, and attitudes that will help students learn to think for themselves and their environment (Rodriguez, 2018). This assertion is met in the results of Table 6 and Figure 2, where there is an improvement in favor of CT to 100% of teachers after the training conducted. Zeleita y Ortiz (2018), from the point of view of students, confirm a better work in the teaching-learning process in teachers, which validates these results.

Table 8: Descriptive analysis of the CT skills test in the experimental group and control group.

		Before Intervention				After Intervention				
	Control group or experimental group	n	Media	Ds	P value	Media	Ds	P value	Effect Size	Type of Effect (Cohen, 1988)
interpretation	experimental	18	1.3	0.49	0.37	2	0.72	0.28	1.5	Great positive
analysis	control	19	0.7	0.40	0.57	1.03	0.22	0.21	0.8	Great positive
	experimental	18	1.3	0.48	0.36	1.8	0.69	0.25		
evaluation	control	19	0.9	0.50	0.55	1.05	0.1	0.09	2.25	Great positive
	experimental	18	1.2	0.41	0.34	1.	0.70	0.27		
	control	19	0.3	0.40	1.33	1	0.48	0.48		

Source: own elaboration.

Table 9: Descriptive analysis of the CT development levels test in the experimental group and control group.

		Before Intervention				After Intervention				
	Control group or experimental group	n	Media	Ds	P-value	Media	Ds	P-value	Effect Size	Type of Effect (Cohen, 1988)
interpretation	experimental	18	3.4	1.04	0.30	4.01	0.61	0.15	0.38	Positive
	control	19	3.02	0.98	0.32	3.02	0.98	0.32		
analysis	experimental	18	3.5	1.17	0.33	3.9	0.67	0.17	0.88	Great positive
evaluation	control	19	2.7	0.90	0.33	2.7	0.90	0.33	0.35	Positive
	experimental	18	3.3	1.01	0.30	3.9	0.57	0.14		
	control	19	2.98	0.90	0.30	2.9	0.85	0.29		

Source: own elaboration.

Moslemi and Habibi (2019), identifies a “teachers increase their self-effectiveness by improving their CT skills.” El 100% of teachers participate and are interested in improving their skills in the management of information and communication technologies (approximately 50% attend training courses) after CT training at the university.

In the work of Fandiño et al. (2021), it is noted that CT improves the cognitive and ontological aspects of teachers, as evidenced by these results.

4.2 Main Results of Student Research in CT Skills

As far as CT skills tests are concerned, the following results were obtained.

Table 8 shows that the mean of the experimental group increased by 30%, confirmed with the coefficient of variation in the standard deviation with a lower percentage. In the control group, there is a slight variation in the same direction. What should be noted is that

the size of the effect (Cohen, 1988) is >0.8 , which is considered a significant positive effect on this ability.

As in this study, the improvement in the application of CT, after an educational intervention, is reported to the literature, such as Ristanto et al. (2020). Although this author uses the same evaluations for these abilities, the outcomes are different albeit similar in terms of context. Portilla et al. (2019), recommend CT instruction to improve the academic performance of students in the context of health studies, which is one of the objectives of this research. Also, Faramarzi and Khafri (2019) address issues of growing self-esteem and maturity, an effect favored for these students.

Table 9 shows the CT development levels. The mean of the experimental group is increased and the coefficient of variation in the standard deviation is confirmed with 4%. The control group displays no significant variation of the mean, the standard deviation, and is confirmed with the coefficient of variation. The size of the effect (Cohen, 1988) is >0.8 is considered a noteworthy positive effect on these abilities.

Table 10: Experimental group contrast and control before and after academic performance intervention.

	Before Intervention				After Intervention			
	Control group or experimental group	n	Media	Ds	Coefficient of variation	Media	Ds	Coefficient of variation
Quarterly ratings	experimental	18	8.13	0.55	6.85	8.07	1.20	14.87
	control	19	8.06	0.64	8.01	8.02	1.01	12.53

Source: own elaboration.

When it comes to CT development levels, Din (2020) holds that such levels are not necessarily associated with improvements in academic performance but do represent improvements in cognition. Cui et al. (2021) discuss a tool to improve the levels of CT development, like this study's intervention, invoking a Likert-type evaluation based on Facione (2020), arguing that this form of educational intervention should be favored in students studying health, hence improving their academic and personal performance.

Table 10 sets out the academic performance obtained in the quarters before and after educational intervention in the experimental and control groups.

As shown in Table 10, the results obtained in terms of academic performance are not statistically significant as the averages and standard deviations remain the same.

Becirovic et al. (2019) finds that improvement of CT skills contributes to improvement in the teaching-learning process, regardless of former performance.

Although Din (2020) reports that there was no improvement in the academic performance of his students, other authors such as Ristanto et al. (2020), De la Portilla et al. (2019) and Faramarzi and Kahfri (2019), find a significant improvement in both CT skills and academic performance. This researcher holds that, in this context of confinement with significant changes in the redesign of the teaching-learning processes, the form of online formative evaluation, disease, and isolation, along with the increase in demand, is linked to these academic results. However, further research is required to resolve this issue.

As for qualitative results, during the educational intervention, the students initially displayed little interest. During development, however, they became increasingly committed to the work was ended, as shown in the responses to the CT's skills questionnaire.

The quality of their work is always significant. At first, the assignments were broad in expectations and vague. For example, a nursing student would be given asked the research question about the risk factors for a diabetic foot? In giving feedback, the student understood that it was too broad a topic and circumscribed the issue to her environment and a specific group of patients. The research question, after researching and understanding the extent of what the diabetic foot means, was altered to address the risk factors for diabetic foot in patients aged 50 to 59 in the population served in (X institution) in a city next to the city of the university (where the student is originally from). This made cohort research viable and achievable.

5 CONCLUSIONS

For the twenty-six teachers, there was a positive impact on CT after training. Zelaita and Ortiz (2018) and Fandiño et al. (2021) report positive impacts on CT training. Valdez-García y López (2021) notes the importance of redesigning teaching among teachers and improving the teaching-learning process when conducting training on CT. It is important to note that, in parallel, positive effects were presented, as reported by Karakaya et al's studio (2021), and in the socialization aspects of teachers, in tandem with adapting students to this new model. In conclusion, CT training is required for teachers before starting any educational intervention on CT. This enables teachers to apply and teach CT.

As for the development of CT skills, there was an improvement in the rating of the CT's skills questionnaire that was attributed to the educational intervention. The interpretation skill goes from a mean of 1.3 (pretest) to 2.5 (post-test). In analysis, the mean goes from one. 3 (pretest) to 2.7 (post-test). In evaluation, it is from 1.2 (pretest) to 2.6 (post-test). In each skill, the size of Cohen's effect (1988) is large positive with values of 1.5, 0.6, and 2.25 in each skill, respectively (interpretation, analysis, and evaluation). The value of p is also significant for the test in general, matching what is reported by Ristanto et al. (2020), Cui et al. (2021) and De la Portilla et al. (2019). The conclusion is that students acquired the CT skills that allowed them to improve their inference, analysis, and evaluation skills.

There was also a strong impact on development levels in the experimental group, as shown in Table 9. The values of the means range from 3.4 (pretest) to 4.01 (post-test) in the interpretation, 3.5 (pretest) to 3.9 (post-test), in the analysis, and from 3.3 (pretest) to 3.9 (post-test) in the evaluation skill. This Table also shows a positive influence on the effect (Cohen, 1988) with values of 0.38 (interpretation), 0.88 (analysis) and 0.35 (evaluation), with the value of p being significant.

In academic performance (Table 10), no statistically significant differences were found, as reported by Ristanto et al. (2020). This result is due to the period of adaptation that both teachers and students had to make. More research should be done to analyze this possibility. Din (2020) also found low academic performance. This effect is also reported by Faramarzi (2019). Roohr and Burkander (2020) find that, even when CT is used by students, their academic performance shows little evolution. What should be noted at this point is that performance did not decrease, remained steady, and this was due to acquired CT skills.

In the initial stage of interpretation in the intervention, there were difficulties in understanding the topics to be developed in the research questions. But in the classroom, during the analysis phase, understanding improved, just as the documents were delivered and attachments to the rubrics were improving.

The students also enjoyed the evaluation phase, especially being evaluated by their peers in an atmosphere of harmony.

Finally, the work integrated the research questions with good analysis and evaluation and was considered feasible and appropriate to the environment and discipline of the students.

These students are expected to continue learning CT skills until they reach self-regulation (final phase of skills described by Facione, 2002). They are therefore improving in their cognitive, psychosocial, and family fields. This intervention is expected to help them get better job opportunities in the future.

As far as the control group is concerned, what is remarkable is that there were no changes in any of the parameters evaluated—CT skills, CT development levels, and academic performance. This is because the control group was not exposed to educational intervention on CT. None of the studies cited so far used control groups. The studies of Din (2020), Cui et al (2021), De la Portilla et al (2019), Faramarzi and Kahfri (2019), Becirovic's et al (2019), Roohr and Burkander (2020) and Tahrir et al (2020), do not mention control groups. The sole exception is Ristanto et al (2020) whose findings, in the differences between the experimental group and the control group, are like this study.

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