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Problem-based learning and the improvement of critical thinking of Medical Technology students at a Peruvian University

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Abstract

The present research work aimed to determine that PBL improves the critical thinking of Medical Technology students of the University of Jaén - 2022. The type of research was applied, quantitative, experimental and longitudinal with quasi-experimental design. The population under study was made up of 94 students from different cycles of the specialty of Medical Technology and all of them made up the study population segmented into two groups: experimental and control; with 47 participants for each group. For data collection, the survey technique was used and the instrument was a critical thinking questionnaire; this was validated using the statistical model of Aiken's V and the content validity was obtained with a coefficient of 1.0. Regarding the calculation of the reliability of the instrument, Cronbach's alpha was used and a coefficient equal to 0.76 was obtained. The findings found with the U of Mann Witney (Z=-6,552 and p-value < 0.05) demonstrate that significant improvement among the experimental and control group therefore the PBL program significantly improves the critical thinking of medical technology students at the University of Jaén.

Keywords: PBL, critical thinking, clarity, precision and accuracy.

Introduction

Among the great concerns of university education is teaching because teachers are needed to propose activities that promote meaningful learning, that the student manages learning autonomously, that work with each other collaboratively and that manage skills transferable to the authentic context, such as problem solving, reasoning, formulations and verifications of hypotheses and multidisciplinary of knowledge in a response to a given problematic situation. To fulfill this purpose, it is necessary to teach with active methods such as Problem-Based Learning (PBL), in which students use critical thinking and work collaboratively to solve a clinical case or problem (Campos, 2019). Likewise, in the age of knowledge in which we live, the most fundamental purpose of modern science education is to educate people who can investigate and establish a correlation between their daily lives and scientific subjects (Pinar, Fatih and Ilhan, 2011).

However, for dozens of years, education policies have been based on memorism at all educational levels (Lara, 2019), being the simplest and most rudimentary action, which has been used over many years disguised under traditional learning, which consists of simply accumulating information itself that can show results in cases represented by a minority, but at present teaching has evolved through pedagogical practice, becoming from rote learning to meaningful learning, which is an educational challenge of the twenty-first century, as a result of the age of knowledge, the implantation of a new meaning to teaching that promotes critical thinking as a way to ensure that students can express opinions, adapt to reality, encourage innovation and problem solving thus achieving their highest academic level (Franco et al., 2014). In higher education it is intended that

educational training is connected to reality, so that it has a concrete and useful meaning in the life of the student (Matienzo, 2020), thus contextualizing the theoretical contents, promoting the development of critical thinking in the resolution of problems of their daily and social life, in order that students develop skills, skills and their future labor insertion (Vendrelli and Rodríguez, 2020). However, current education has shown one of the main limits in the context of the twenty-first century: the segmentation and partialization of knowledge (Cantoral, 2005), which is one of the legacies of the classical models, product of the industrial revolution of the nineteenth century. Despite this, pedagogical and social movements have emerged that seek to transcend this way of educating, since approaches such as complex thinking, connectivism and invisible learning underline the value of the inter and multidisciplinary, before a paradigm based on the univocal and the experimental scientific method (Cantoral, 2005). Derived from the classical paradigm of education, the field of mathematics has faced difficulties due to the organization of the thematic contents and their link with the achievement of competences, while the disciplinary ones show a greater relationship with the program, since it emphasizes the importance of know-how as one of the main components to be achieved. However, in addition to this, it is evident that the training of teachers in many cases is not optimal for the achievement of the graduation profile established in the latest educational reforms, since a large part are graduates of undergraduate or postgraduate degrees where they have not been explicitly prepared for teaching, which entails a series of difficulties when addressing the knowledge of the area for educational purposes, causing a teaching based on oral presentation by the teacher, the realization of mechanized exercises and the decontextualization of knowledge (Cantoral, 2005). In today's global and plural society and, frequently, invaded by abundant information through various means of communication, both virtual and physical, it is necessary to develop critical thinking and is a fundamental competence in the education of university students (Bezanilla, Galindo and Poblete, 2021). Companies have also considered this competence to be essential for professional development in an innovative environment. Several authors have studied its concepts and processes as a key element in education and training. The skills of thinking critically and solving problems must be managed and mastered by university students to face the present and future labor market competitively. Therefore, graduates must equip themselves with the skills required by the future workforce to ensure that they are marketable. However, much research has shown that university graduates still have deficiencies in managing the skills required by industries as a result of the rapidity of technological development (Sharif, Lee and Rahman, 2021). Likewise, the United Nations Cultural, Scientific and Educational Organization (UNESCO, 1998), states that higher education for the twenty-first century must train students with skills to analyze the problems of the community, investigate solutions, use them and assume social responsibility (Article 9. Innovative educational methods: critical thinking and creativity). At the national level, for many years one of the main causes of the deficiencies in learning and the low levels of achievement obtained by Peruvian students in the different international evaluations, have focused only on the teaching of the teacher, treating him as the only culprit, but in reality, there is another variable that significantly affects, which is how the student learns. Learning does not simply involve acquiring, reproducing or executing knowledge, it means being able to master, transform and use that knowledge to solve authentic problems (Beas, Santa Cruz, Thomsen and Utreras, 2001). So, to face these challenges, it needs educational systems that prioritize the application of teaching methods that lead to developing the potential area of critical thinking skills and the integral formation of university students (Moreno and Velázquez, 2017). Thus, there are several active methodologies to develop critical thinking (Bezanilla, Fernández, Poblete and Galindo, 2019). However, very few understand it as action and commitment (Bezanilla, Poblete, Fernández, Arranz and Campo, 2018). In the same way, there are universal intellectual standards to measure this type of thinking and undergraduate students of Medical Technology at the National University of Jaén are not exempt from this reality on the contrary they are susceptible and then teachers can apply active teaching methodologies such as PBL and then measure their critical thinking. Faced with this reality, the following research question was posed: How does PBL improve the critical

thinking of Medical Technology students, Jaén-2021? This research is theoretically justified because it allows the deepening and breadth of knowledge as a product of the analysis of epistemological and pedagogical theories regarding the relationship between PBL and critical thinking. Likewise, various theoretical points of view on the study variables are contrasted. In the same way, it provides specific data on the incidence of PBL in critical thinking. Socially, it has relevance because the discovery of the incidence relationship of PBL in the improvement of critical thinking contributes to innovate with new active and effective learning methods to form reflective students, with investigative skills and capable of solving real problems of their environment for the benefit of their families and the community where they operate. In the same way, this research has practical utility because it suggests recommendations for teachers and managers based on the observed phenomenon to correct traditional pedagogical and rote practices and move to an active, reflective and effective methodology in the resolution of real problems. From the methodological point of view, this work is justified because the type and design of research, as well as its valid and reliable techniques and instruments, serve as a reference for new research. The general objective was to demonstrate that PBL improves the critical thinking of Medical Technology students, Jaén-2021. And the following specific objectives were formulated: Identify the level of PBL and the level of critical thinking of students, demonstrate that PBL improves the clarity, precision, accuracy, relevance, breadth, depth and logic of critical thinking of Medical Technology students, Jaén- 2021. As for the research question posed above, the following general hypothesis was formulated: PBL improves the critical thinking of Medical Technology students, Jaén-2021. And the specific hypotheses were that PBL improves the clarity, precision, accuracy, relevance, depth, breadth, and logic of critical thinking.

METHODOLOGY

Type and design of research

The research was quantitative, experimental, applied and longitudinal with quasi-experimental design.

The scheme of the design, was:

Fase Pre Test Fase Post test

GE: O1……...X……. O2

GC: O3……O4

Where:

GE: Experimental group

GC: Control Group

O1 : Measurements of the PBL pre-test in the experimental group.

O2 : Post-test measurements of PBL in the experimental group.

X: Application of the PBL method.

O3 : Pre-test measurements of PBL to the control group.

O4 : Post-test PBL measurements to the control group

Variable and operationalization

Dependent variable

Conceptual definition of critical thinking: It is the process of the way of thinking about any topic, content or problem in which the thinker improves the quality of his thought by seizing the inherent structures of the act of thinking and subjecting them to universal intellectual standards. It involves effective communication and problem-solving skills and a commitment to overcoming the natural self-centeredness and socio-centrism of the human being. (Paul and Elder, 2003).

Operational definition of critical thinking: It is the numerical measurement of seven criteria to solve problems with critical thinking that researchers have called universal intellectual standards and serve to verify the quality of critical reasoning about any situation or problem and are the level of clarity, precision, accuracy, depth, breadth, relevance and logic of thought (Paul and Elder, 2003).

Population, sample, sampling and unit of analysis

The study population was made up of a total of 94 medical technology students from the National University of Jaén, from cycles II, III, IV, V, VI, VII and VIII.

Inclusion criteria: The inclusion selection criteria were male and female, students from the I to the VIII cycle of the specialty of medical technology of the year 2021. They also voluntarily agreed to participate in the study and signed the informed consent statement.

Exclusion criteria: Do not sign the informed consent. Non-enrolled and 3rd and 4th enrollment students who only take one course per cycle.

Data collection technique and instrument

Technique

To collect data from this research, the survey technique was used and consisted of collecting information from the study sample so that the questioned subject understands the question the same as the other respondents (Behar, 2008).

Instrument

A questionnaire was applied with which the variable dependent on critical thinking and its dimensions such as; clarity, precision, accuracy, depth, breadth, relevance and logic.

This questionnaire was structured by 32 items with the aim of measuring the dimensions of clarity (4 items), accuracy (5 items), precision (5 items), relevance (4 items), depth (5 items), amplitude (4 items), and logic, (5 items). The value scale was Likert with 5 alternative answers: (5) always; (4) almost always; (3) sometimes; (2) almost never and (1) never. The rating starts from a score of 1 to 5 points. The measurement scale of the variable was ordinal and was made up of the following ranges and category:

Dependent variable: Critical thinking

(32 -126) LOW

(127-168) MIDDLE

(169-160) HIGH

Dimensions:

Clarity:

(10-30) LOW

(31-40) MIDDLE

(41-50) HIGH

Accuracy:

(21-63) LOW

(64-84) MIDDLE

(85-105) HIGH

Precision:

(06-18) LOW

(19-24) MIDDLE

(25-30) HIGH

Relevance:

(06-18) LOW

(19-24) MIDDLE

(25-30) HIGH

Depth:

(05-15) LOW

(16-20) MIDDLE

(21-25) HIGH

Amplitude:

(05-15) LOW

(16-20) MIDDLE

(21-25) HIGH

Logic:

(05-15) LOW

(16-20) MIDDLE

(21-25) HIGH

Data analysis method

SPSS software was used to process and analyze the data. Data were organized into descriptive frequency tables and cross tables. To check the normality of the sample, the Kolmogorov-Smirnov normality test was applied and then the hypothesis was verified by means of the ordinal logistic regression analysis that is used to treat independent variables when the events whose probability is to be explained are ordinal categorical variables, that is, those whose values not only differentiate the subjects, but they also allow to establish an order between these (Heredia, Rodríguez and Vilalta, 2014).

RESULTS

Table 1 shows that there is a significant difference in the median levels of critical thinking for both the experimental and control groups before and after the application of the PBL program; since in both cases the results show a Z< 1.96 and p<0.05.

Table 1. Wilcoxon test to compare median levels of critical thinking in related samples of Medical Technology students, Jaén- 2022.

		Postest - Pretest
Experimental	Z	-5,969
	Asymptotic (bilateral) sig.	,000
Control	Z	-5,969
	Asymptotic (bilateral) sig.	,000

Table 2 shows that the research hypothesis is true because the medians are different, that is, the application of the PBL program significantly improved the critical thinking levels of the experimental group compared to the control group of Medical Technology students, Jaén- 2022; Z<1.96 and p<0.05

Table 2. Mann-Whitney U-test to compare median differences in critical thinking levels in independent samples of Medical Technology students, Jaén- 2022.

	Median difference between the experimental and control group
Z	-6,552
Asymptotic (bilateral) sig.	,000

In Table 3, it is observed that after the post-test the percentage of students who made up the experimental group and received the PBL program were located in a higher percentage at the medium and high level compared to the control group; 85.11% compared to 19.15% respectively.

Table 3. Comparison of the levels of self-realization of Medical Technology students, Jaén- 2022.

Levels	Experimental group				Control group			
	Pretest		Postest		Pretest		Postest	
	f	%	f	%	f	%	f	%
High	0	0.00	8	17.02	0	0.00	0	0.00
Middle	4	9.51	32	68.09	3	6.38	9	19.15
Low	43	91.49	7	14.89	44	93.62	38	80.85
Total	47	100.00	47	100.00	47	100.00	47	100.00

Table 4 reveals that after applying the post test there is a significant difference in the medians in almost all dimensions of critical thinking for both the experimental group and control after the application of the PBL program; since in both cases the results show a Z < 1.96 and p<0.05.

Table 4. Wilcoxon test to compare median levels of critical thinking in related samples of Medical Technology students, Jaén- 2022.

GROUP		PosD1 – PreD1	PosD2 – PreD2	PosD1 – PreD1	PosD1 – PreD1	PosD1 – PreD1	PosD1 – PreD1	PosD1 – PreD1
Experimental	Z	-5,995[b]	-5,911[b]	-5,913[b]	-5,915[b]	-5,850[b]	-5,790[b]	-5,912[b]
	Asymptotic sig. (bilateral)	,000	,000	,000	,000	,000	,000	,000
Control	Z	-5,674[b]	-5,317[b]	-5,805[b]	-5,769[b]	-5,248[b]	-5,207[b]	-5,190[b]
	Asymptotic sig. (bilateral)	,000	,000	,000	,000	,000	,000	,000

Table 5 reveals that after the post test, the measurements of the median differences of all dimensions of critical thinking are significant, that is, that the application of the PBL program was efficient in the significant improvement of all dimensions of critical thinking of the experimental group with respect to the control

group of Medical Technology students, Jaén-2022; Z<1.96 and p<0.05.

Table 5. Mann-Whitney U test to compare median levels of critical thinking dimensions in independent samples of Medical Technology students, Jaén- 2022.

	Difference_clarity	Difference_accuracy	Difference_precision	Difference_relevance	Difference_depth	Difference_amplitude	Difference_logic
Z	-4,008	-4,976	-4,778	-5,457	-5,248	-5,307	-5,840
Asymptotic (bilateral) sig.	,000	,000	,000	,000	,000	,000	,000

CONCLUSIONS

The results found showed that the Problem-Based Learning program significantly improved the critical thinking of Medical Technology students. The students who received the PBL program were placed in a higher percentage at the medium and high level compared to the control group. The results showed that the PBL Program significantly improved the clarity, accuracy, precision and relevance of critical thinking. The findings allowed to demonstrate that the PBL Program significantly improved the depth, breadth and logic of critical thinking.

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