Researchers' Seedbeds for the Development of Research Skills in Universities

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Abstract: The objective of this study is to demonstrate the effects of the application of the pedagogical strategy "researcher's seedbed" in the development of research skills in universities. This research is of quasi-experimental, longitudinal and prospective design, where 2 groups were formed: control and experimental, of 18 students each. A validated instrument was used to measure the research competences, as well as a rubric for the evaluation of the research projects. It began with a pre-test, and after 14 weeks of the development of the strategy, through different educational sessions, the post-test was administered. Likewise, the research projects carried out were evaluated. The results obtained showed that the pedagogical strategy had a positive effect on the development of research skills, with the highest evaluation being found in 40% of the students, with statistically significant differences between the control and experimental groups (Mann Whitney U, p=0.007), and between the pre-test and post-test (Wilcoxon, p=0.00). In the development of cognitive and procedural competence, an effect was also found in the strategy, but not in the attitudinal competence (Mann Whitney U, p=0.496). The application of this study is based on the fact that the formation of research groups in universities strengthens formative research in higher level students. This study shows the benefits of the implementation of strategies for the development of research competencies, since the product will be to train professionals with a scientific culture in favor of society.

Keywords: Ability, capacity, educational research, learning strategy, didactics.

1. INTRODUCTION

Formative research represents one of the pillars of the university as a training institution. It is considered a strategic axis for human and sustainable development, where the participation of undergraduate and graduate students has the objective of improving the quality of education, as well as the production and dissemination of knowledge appropriately and competitively, with a scientific and humanistic perspective to respond to the multiple social problems (Restrepo, 2003).

Research skills, as defined by Tobón, Pimienta and Garcia (2010) are the "integral actions to identify, interpret, argue and solve problems of the context with suitability and ethics, integrating the knowledge to be, knowledge to do and knowledge to know". However, it is observed that students do not develop these skills, for various reasons, whether financial, institutional, teacher or student. It has been shown that they have an average level of research in cognitive, technological, communication and socio-affective areas, and therefore have low performance in the preparation of proposals, papers and research protocols (Salcedo, De La Torre and Piñón, s.f.; Jaik and Ortega, 2008; Estrada, 2014).

This is why the curriculum of the different training levels should expose students to situations that encourage them to acquire an attitude of questioning reality, of scientific rigor, as well as knowledge and skills that guarantee their training (Aldana, 2012; Herrera, Fernández and Orta, 2012; Montes de Oca, and Machado, 2009). However, clearly many teachers do not have adequate teaching methods, coupled with the lack of implementation of pedagogical strategies developed for this purpose. In many cases, there is a curricular structure that shows teaching in research more informative than formative, which is reduced to the teaching of one subject, the Research Methodology or Thesis.

Therefore, universities are currently in a process of education in skills and implementation of pedagogical strategies, to achieve professionals with skills that allow them from their training, to perform adequately, enabling the challenge of facing relevant problems to build scientific knowledge or reconstruct those already processed, to incorporate research skills in their daily lives, in their work development, in addition to working

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towards more meaningful learning (Gorina, Alonos and Zamora, 2007; Gonzalez and Rasilla, 2011).

It is considered that being equipped with the mentality of a scientist is a valid way of knowing reality and facing it, as well as transferring this knowledge and methodology to the profession and daily life; Therefore, this study had a social relevance, since it was carried out in a career in the area of Health, where research usually focuses on products, on the result, so it is necessary to develop these skills, since future professionals will improve their performance in the care area, since as a member of the health team, must be scientific both for diagnosis, as to decide the best treatment plan, for the benefit of their patients. (Gayol, Montenegro and Tarrés, 2008).

Studies have shown that the implementation of strategies has fostered the development of scientific research and attitudes, which impact on various areas of vocational training. (Fernández and Gómez, 2012; Castillo, 2011). The use of semester research projects (PIS), problem-based learning (ABP), the journal club, the theoretical essay, learning by discovery, the pre-symposium, the symposium, etc., are strategies that are considered to be an effective intervention due to the good results obtained in research processes (Tejada, Tejada, and Villabona, 2008).

Thus, the proposal of research seedbeds constitutes an extracurricular strategy to promote research in the university and for students and professors to be protagonists of development (Abello and Yahemn, 2007; Abello and Pardo, 2014; Maldonado, Landazabal, Hernandez, Ruiz and Claro, 2007; Quintero, Munévar and Munevar, 2008). This strategy has provided indicators that allow the university to achieve excellence as a center of science, research and innovation, beyond the curricula implemented for this purpose.

Likewise, the proposals for an integrated curriculum for the development of research competencies from undergraduate training to advanced postgraduate training have shown that they constitute a scheme for the development of these competencies, contributing to the relevance and validity of the curriculum centered on the student (Fernández and Gómez, 2012; López, 2009; Guerrero, 2007; Fernández and Cárdenas, 2015; Numa-Sanjuan and Márquez Delgado, 2019).

This study has a social relevance, since it was executed in a career in the area of Health, where research is more focused on products, on the result, which is necessary because future professionals will improve their performance in the care area, since as a member of the health team, must be scientific both for diagnosis, as to decide the best treatment plan, for the benefit of their patients.

For what expressed previously, the present investigation had like objective to identify which are the effects of the application of the pedagogic strategy: "Researchers' Seedbeds", in the development of the investigative competitions in undergraduate students of a Peruvian university.

2. MATERIAL AND METHODS

2.1. Research Design

Quasi-experimental research, where the design of two groups was used, with a non-random control group; longitudinal and prospective, with a quantitative approach, where the possible cause-effect relationships were evaluated, exposing an experimental group to the action of the pedagogical strategy "researchers' seedbeds" and contrasting the results with a control group, in which the strategy was not applied.

2.2. Sample Design

The population of the study was made up of all the undergraduate students of the x cycle of the faculty of dentistry of the universidad nacional mayor de san marcos. The type of sampling was non-probabilistic, so the sample was constituted by 40 students, distributed in 2 groups, the experimental one (researchers' seed group) integrated by volunteer students who signed the informed consent, and the control group, constituted by the same number of those who were not part of the strategy.

2.3. Data Collection Methods and Procedures

The method used was the survey; and as an instrument, a questionnaire to measure research competencies of 43 items, measured through a lickert scale, where it never represents the lowest perception and always, the highest, which was made based on an adaptation to the one made by Lopez (2009), with a content validation through expert judgment, a criterion validation by halves split by the spearman-brown coefficient (0.923) and construct validity through an exploratory factor analysis, where the structure in 3 factors (cognitive, procedural and attitudinal) was

confirmed, which represented 87.49% of the variance of the factors presented. In addition to the application of a pilot test, where its excellent reliability was determined (cronbach alpha= 0.934), the product made by the students, consisting of their research project, was also evaluated through the application of a rubric. The procedure of data collection included activities of awareness and sensitization on the strategy, then the consent of the students was requested, where voluntarily the participants integrated the experimental group and an equivalent number conformed the control group.

The evaluation and measurement of the research skills in both groups were carried out through the questionnaire to measure the research skills. The pedagogical strategy "researchers' seedbeds" was evaluated through a validation matrix by the same 5 experts who reviewed the questionnaire to measure research skills, where the agreement was obtained among the experts for its application.

After its validation, the strategy was implemented, which lasted 14 learning sessions, with the application of guides, working material, etc., and then applied to the experimental group. Monitoring and follow-up activities of the experiment were carried out. Finally, the research skills in both groups (experimental and control) were evaluated and measured again.

RESULTS

Data analysis and processing were performed using SPSS version 20. Non-parametric hypothesis testing was applied, with a 95% confidence level, and the Mann Whitney U test was applied to compare the control and experimental groups, and the Wilcoxon test was used for pre-test and post-test analysis. Likewise, the analysis of the rubric used to evaluate the research projects was carried out using the Chi-square test. When the analysis between the control and experimental group was performed in the pre-test, no statistically significant differences were found (Mann Whitney's U, p>0.05). The comparison between both groups in the post-test, after the development of the strategy, showed differences in the development of the research competence as well as in the conceptual and procedural dimensions, the results shown in Table **1**.

The evaluation between the pre-test and post-test of the investigative competences was carried out through the Wilcoxon test, where it was determined that there are statistically significant differences between both moments of the evaluation (p=0.000)

The descriptive analysis of the items that made up the instrument shows us that the methodological part was the one that had the least perception of its development in the students, the data collection procedure techniques, as well as the statistical part, were perceived by 10% and 20% respectively rarely before.

In the same way, to evaluate the level of competence in both groups, an evaluation heading was used for the research projects, where the levels from zero (competence not achieved) to competent (competence achieved) were considered. The Chi-square homogeneity test was applied, and the difference between both groups was established (Table **3**).

DISCUSSION

There is a need for training in research throughout the entire educational process of students, since it has been proven that research skills are not developed by taking a single subject, but rather that it is achieved over time and where the students themselves are

Table 1: Comparison of the Perception of the Development of Research Skills between the Control and Experimental Groups in the Post-Test

COMPETENCES	Control			Experimental			P*
	SOMETIMES	ALMOST ALWAYS	ALWAYS	SOMETIMES	ALMOST ALWAYS	ALWAYS	
Investigative Competences	4 (20%)	14 (70%)	2 (10%)	0 (0%)	12 (60%)	8 (40%)	0,007
Conceptual	3 (15%)	16 (80%)	1 (5%)	0 (0%)	13 (65%)	7 (35%)	0,006
Procedural Attitudinal	10 (50%)	9 (45%)	1 (5%)	1 (5%)	14 (70%)	5 (25%)	0,001
	0 (0%)	15 (75%)	5 (25%)	0 (0%)	13 (65%)	7 (35%)	0,496

*Mann Whiteny U test, p<0.05.

Table 2: Level of Perception of Research Skills in the Experimental Group

		NEVER	ALMOST NEVER	SOMETIMES	ALMOST ALWAYS	ALWAYS
PROBLEM PLANNING	PROBLEM	0%	0%	10%	55%	35%
	JUSTIFICATION	0%	0%	30%	30%	40%
	OBJECTIVES	0%	0%	20%	50%	30%
THEORETICAL FRAME	ANTECEDENTS	0%	0%	10%	55%	35%
	THEORETICAL BASES	0%	0%	0%	65%	35%
	HYPOTHESIS	0%	0%	20%	50%	30%
	VARIABLES	0%	0%	25%	50%	25%
METHODOLOGY	DESIGN	0%	0%	20%	55%	25%
	SAMPLE DESIGN	0%	0%	30%	50%	20%
	STATISTICAL PROCEDURE	0%	10%	35%	25%	30%
		0%	20%	30%	45%	5%

Table 3: Level of Competence Achieved in the Experimental and Control Groups in the Evaluation of the Research Projects

Levels of competences of projects	Control	Experimental	Total	P*
SATISFACTORY (Medium)	11 (27,5%)	0 (0,0%)	11 (27,5%)	0,000
COMPETENT (Achieved)	9 (22,5%)	20 (50%)	29 (72,5%)	
Total	20 (50%)	20 (50%)	40 (100%)	

*Chi square of Pearson= 15,172; p<0,05.

involved in their learning, that is, they learn to research, by doing research.

This study evaluated not only the students' perception related to the development of their competences, but also through the research projects carried out by them, finding that the applied pedagogical strategy was effective in the development of these competences; similar results were found by Salcedo, De la Torre and Piñon (s.f) and Jaik and Ortega (2008), where they obtained acceptable to satisfactory competences. Likewise, research carried out in other countries such as Colombia, Venezuela and Cuba, where it has been demonstrated in years of experience that their universities have used this strategy of research seedbeds as one of the most pertinent mechanisms for the development of research activity and the projection of young researchers, as well as Osorio (2008) states that this pedagogical strategy favors superior thought processes. Research with a qualitative approach, such as that of González and Rasilla (2011), shows that the design of strategies focused on the achievement of specific competencies represents a valid alternative to contribute to the appropriation of scientific culture. Abello and Yahemn (2007) determined in a 10-year longitudinal study that the researcher seedbed program has managed to train a large number of professionals with a research profile and has encouraged this activity in an interdisciplinary way in its students. Maldonado, Landazabal, Hernández, Ruiz and Claro (2007) also established that the university was the appropriate setting for research and that formative research is carried out through these research seedbeds. Therefore, it could be said that this strategy should be a long-term training proposal for the university, which has as its purpose the generation of human talent qualified in research, from which emerge committed and motivated young people, with a high possibility of continuing academically with master's and doctoral degrees, whose product is reversed and used by the university and for the benefit of society. From this, we can deduce that it is beneficial for the universities to support the development of these pedagogical strategies such as seedlings, because they strengthen research, promote interaction between professors and students, and in

this way, generate the capacity to work in an interdisciplinary team

Cognitive, procedural and attitudinal dimensions were measured. In the cognitive and procedural dimensions, significant differences were found between both groups, with an improvement in the experimental group. When evaluating each of the items that conformed these dimensions it was possible to demonstrate that the "statistical treatment" and to make a "report in another language" were one of the remarkable improvements in this investigation. Thus, Martinez and Orozco (2011), also consider necessary the promotion of basic skills such as comprehension and critical reading, writing, calculation through statistical software and the handling of a second language, which are elements difficult to find in undergraduate and graduate students. Researches such as the one carried out by Maldonado, Landazabal, Hernández, Ruiz and Claro (2007) determined that the investigative competence is inclined to the application of knowledge, they consider that the development of the procedural dimension will allow the researcher to permanently build the forms of organization of which to do research, as well as the main modes of communication and interaction between the research groups of the academic or productive community, in addition to society.

Salcedo, De La Torre and Piñon (s.f) determined in their research that students have low performance in the elaboration of proposals, papers, projects and research protocols. They also recommend learning a statistical package for data processing, as well as publishing in refereed or indexed journals, preparing scientific articles and participating in a congress with the results of research. With this, it becomes evident that it is necessary to apply pedagogical strategies that include a didactic that favors the articulation of formative research and research training from the beginning of the undergraduate program and in a transversal manner in the curriculum, which forms an integral part of the student's formation process, as opposed to the traditional way in which they have been taught to do research; Although the curricula include subjects such as research methodology and statistics, some students even perform poorly in the above-mentioned areas, where, despite carrying out research work, they have not achieved minimum standards in research skills.

In the attitudinal dimension, no significant differences were found between the control and experimental groups in the post-test. (Mann Whitney's U test, p=0.496), which shows us the similarity between both groups after the application of the strategy. Different results were obtained by Tejada, Villabona and Angel (2008) who carried out an investigation where they described the pedagogical strategy of the seedbeds from the beginning of the undergraduate, where through qualitative and quantitative approaches, they obtained effective results both in attitude and in aptitude in front of the investigative processes on the part of the students. Gonzalez (2007) also designed, executed and evaluated a program based on cooperative learning to develop, improve and consolidate favorable attitudes toward research, social skills and ethical values in university students. The results showed that the proposed program was highly effective for the development in the mentioned areas, concluding that the research seedbeds are conformed as an environment designed to identify and reaffirm the research vocation.

Therefore, it can be concluded that the pedagogical strategy "researcher's seedbed" had a positive effect on the development of research competencies, with improvements in the students' perception of the development of these competencies. In the evaluation of the research projects, statistically, significant differences were also found between both groups, with a level achieved as "competent" in the experimental group.

Likewise, in the cognitive and procedural dimension, the effectiveness of the pedagogical strategy was tested, as opposed to the attitudinal dimension. After the analysis, it can be concluded that the university is the entity that trains future professionals, so the importance of the curricular plan and the development of research competencies can be affirmed, that is, with the knowledge of the research process, research skills, attitudes and values, and motivation towards research. Therefore, López (2009) proposes an integrative curriculum for the development of research competencies from undergraduate training to advanced postgraduate training, focused on the development of formative research, under what was proposed by Fernández and Gómez (2012).

CONCLUSION

1. It is concluded that the pedagogical strategy "researcher's seedbed", has a positive effect on the development of research competencies,

presenting improvements in the students' perception of the development of these competencies. Similar results were found by Salcedo (2008), Osorio (2008) and Abello (2007), who determined that these strategies propitiate superior thought processes and manage to form professionals with a research profile.

2. In the cognitive and procedural dimension, the effectiveness of the pedagogical strategy was proven. Similar results were presented by Martinez and Orozco (2011) and Maldonado *et al*. (2007), where they coincide in the improvements of basic skills such as critical reading and writing. Likewise, Salcedo, De La Torre and Piñon also determined the low performance in the development of research proposals, as well as in the use of statistical software and the handling of a second language.

3. In the attitudinal dimension, no effectiveness of the strategy was found, in contrast to the results issued by Tejada, Villabona and Angel (2008) and Gonzales (2007), which showed that the proposed program develops favorable attitudes towards research in university students.

4. After the analysis, it can be concluded that the university as an entity that trains future professionals, should include or reinforce in its curricular plan the development of research competencies, from undergraduate training to advanced postgraduate training, focused on formative research.

5. It is suggested to carry out research with a qualitative or mixed approach and of a longitudinal type in order to obtain an adequate follow-up of the students in their scientific training and to evaluate the effectiveness of the strategy, both in undergraduate and graduate students.

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