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Learning for research and scientific production: experimental results in undergraduate students in Peru

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Abstract

Peru is one of the Latin American countries with the lowest research productivity. Therefore, we designed and tested a training model to teach research skills to students for one semester. We implemented the model in one mid-sized Peruvian university, analyzing 400 students (Experimental Group=200, Control Group=200) in their third undergraduate year. Our educational model resulted in favorable changes in the students' knowledge of research methodologies and the motivation to do research. The paper ends with practical advice and applications for tertiary education institutions that look for strategies to boost research productivity through the involvement of undergraduate students in the research process.

Keywords: *Undergraduate research; research productivity; undergraduate students; research processes; peruvian students.*

Introduction

Scientific research is done in different ways based on the location, closely related to the social and financial development of a country or region (Ynalvez and Shrum 2011; Pereyra-Elías, Huaccho-Rojas, Taype-Rondan, Mejia & Mayta-Tristán, 2014). Scientific productivity of each country has been counted by the number of publications and their impact on the scientific world; with a percentage of each region and organizations in the national and international scientific development according to various indicators or rankings (Beerkens 2013).

As the aim of the scientific research is to provide knowledge, it may be useful for decision making or developing new research work where publishing in indexed scientific magazines is necessary to support the quality and allow circulation in the scientific community (Taype-Rondán, Carbajal- Castro, Arrunategui-Salas, & Chambi-Torres, 2012). Universities are one of the main institutions disseminating and developing research because they group different academics and researchers, including the students involved in professor's research or do their own.

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Lately, one of the most important functions and tasks in undergraduate and postgraduate years is research in the fields of science, technology or humanistic (Sánchez-Carlessi 2017). Research for the author can be executed in a formal and organic manner at university, as well as applied research through classroom training done by the professor together with the students.

From this viewpoint, applied research can be learned and taught in theory and practice, training the students to understand research and on-site investigation; therefore, professors must not be limited to teaching or conveying methodologies and research techniques (Numa-Sanjuan and Márquez 2019). Training and research are two key activities to be done by those in a university developing graduates that will drive improvement in every humankind dimension (Okokpujie, Fayomi, Ogbonnaya & Fayomi. 2019). Psychologists recognize that it is important for undergraduate students to participate in research activities with a more ambitious approach than just passing a mandatory basic course, as this provides them with various academic benefits, such as appreciation of the research process, critical thinking and enthusiasm for intellectual activities (Hu, Kuh, & Gayles, 2007; Woodzicka, Ford, Caudill, &Ohanmamooreni 2015).

Education beinga basic entry for the development of individual skills in the scientific research field (Sarmiento, Silva, & Gameren, 2019). Tertiary education has the potential to foster social cohesion creating opportunities for the students to discuss relevant issues and develop proper institutional behaviors, including research quality and motivation to generate knowledge, a potential that fully depends on the good governance of the organization and the nature of their interaction (Visser- Wijnveen,van der Rijst & van Driel, 2016; Schweisfurth, Davies, Pe Symaco & Valiente, 2018).

Because of the underinvestment in science and technology, the small number of professionals dedicated to technical research and development, or the higher cost of scientific material and equipment, scientific productivity is not a priority in Latin America, therefore, the percentage is much lower compared to countries in North America and Europe (Guerrero-Casado 2017).

In 2015 –according to the Ibero-American Science and Technology Indicators Network's data– investment in R&D was 0.75% of the Gross Domestic Product (GDP) in Latin America, while it was 2.79% in United States and 2.05% in the European Union. (Guerrero-Casado 2017). Furthermore, developed countries dedicate an average 3% of their GDP to research and development, while the Latin American average is 0.57%, and 0.1% in Peru (Díaz, Manrique, Galán & Apolaya, 2008; CONCYTEC [national science, technology and innovation board] 2016). In Latin American countries the percentage of research and researchers is small, possibly due to lack of interest in publishing and developing knowledge in the continent or simply because of a lack of suitable personnel dedicated to research and teaching investigation methods (Oróstegui-Pinilla, Cabrera-Samith, Angulo-Bazán, Mayta-Tristán, & Rodríguez-Morales, 2009).

According to the ranking of scientific publications by country prepared by the Scimago portal, the first five countries that lead these rankings are the United States, China, the United Kingdom, Germany and Japan. In Latin America, the top five countries in the ranking are Brazil (position 15), Mexico (position 28), Argentina (position 37), Chile (position 46) and Colombia (position 50). Peru occupies position 73 on this list. The United States had a scientific production of 12,070,144 papers in 2018 (Scimago Journal and Country Rank 2020); therefore, the integration of scientific research at all levels of university education is part of the culture of this country. An example of this is the integration of undergraduate students into research teams. For example, we can mention the single faculty with multiproject and multidimensional team, generally made up of a faculty member, undergraduate and graduate students; and models from multiple institutions that constitute a team whose purpose is the generation and exchange of ideas within diverse scientific research communities. This allows students to appreciate how the different research models, resources and cultures of each institution influence the research process (Woodzicka et al. 2015). Worldwide, there are various initiatives that promote research culture at the undergraduate level; for example, the Reinvention Centre for Undergraduate Research in the United Kingdom, the Tecnológico de Monterrey that develops research activities using various strategies to produce scientific knowledge and promote research in Mexico (Galeano,Morales-Menendez &Cantú2012), the Council on Undergraduate Research and the National Science Foundation in the United States (Horn, Hendel & Fry, 2007), the latter being a government agency that promotes research in the non-medical field of science and engineering. Another important initiative is the UNITWIN (University Twinning and Networking) / UNESCO Chairs Programme, through which cooperation between universities is promoted at the international level, which share and reinforce their capacities, thus promoting social development (UNESCO 2017).

In contrast, there is a deterioration in the resources allocated to research training in Latin America. This leads to low scientific production and publication; therefore, it is necessary to reinforce academic programs to give greater importance to written science communication and, at the same time, strengthen research skills so that scientific publications increase(Aguilar-Vargas, Rodríguez-

Castellanos, Baeza, & Méndez, 2016). Scientific production in Latin America represents 2.6% of all publications worldwide (Cantor, Sánchez, Figueroa, Mesa & Guerrero, 2015), and is mainly limited to medicine, neglecting other areas of science and humanities. In Latin American countries, medical students have organized the "Scientific Societies of Medical Students", which seek to focus their university education not only on healthcare research, but also on scientific research (Mayta- TristánCartagena-Klein, Pereyra-Elías, Portillo & Rodríguez-Morales, 2013).

As in the rest of Latin America, scientific production in Peru is low. Among other causes, this is due to a low research and publication culture, a shortage of personnel for disciplines aimed at creating research skills in undergraduate students, poor scientific production by professors/researchers, and lack of support networks for publishing scientific journals prepared by the students themselves (Oróstegui-Pinilla et al. 2009; Murray and Matsuno 2014). The main challenge that Peru faces in terms of the participation of undergraduate students in research is to achieve the minimum standards required to be located within the main world rankings. This challenge becomes increasingly difficult to achieve, as developed countries maintain an accelerated pace in terms of research, widening the existing gap to achieve this objective (Sánchez Carlessi2016). In many Peruvian universities, scientific research is an extracurricular activity for students, for which they do not have time; the interest in publishing falls on a few curious and persevering students (Arroyo-Hernández, De la Cruz, & Miranda-Soberon, 2008). Furthermore, students perceive that the scientific research training provided by the university is decadent (Mayta- Tristán et al. 2013). Most students are almost mandatorily exposed to the scientific community, underpressure to do research projects even without having the basic skills to do so, creating a lack of interest (Osada, Ruiz-Grosso & Ramos, 2010). Peru is in a highly disadvantaged position compared to similar countries in the region. Only 0.2% of the PEA (Población Economically Activa [labor force]) in Peru are researchers, while the average in Latin America and Caribbean is 1.3%, and 12.7% in the OECD's countries (CONCYTEC 2016). The main research practices in this country are developed by research societies, in which graduates and undergraduate students act as "research seedbeds", carrying out analysis of scientific articles and project discussions. In the field of medical research, hospitals have an important role; however, research is not usually conducted in most of them (Miyahira 2009). These "research seedbeds" seek to train undergraduate students in research through different activities (Medina Coronado 2018). In Peru, the little research culture that exists for undergraduate students is limited to the medical career. In other areas such as engineering, students frequently drop out because the career is highly theoretical in focus with little useful practice for working life, and postgraduate study is required to learn topics that are more advanced in research and development (Murray and Matsuno 2014).

Undergraduate universities in Peru must teach the student both the process of designing a research project, its stages and the process of scientific publication (Molina-Ordóñez,Huamaní&Mayta- Tristán,2008), providingthe assistance and training required for the students to use their theoretical, methodological and technical knowledge linked with research topics they regularly address; hence, finding the methods and design used, observation records, analysis and tools needed(Sánchez- Carlessi 2017). Thus, in this article we present the design and application of a didactic model for evaluating students from one university in Peru, to assess whether there was a change in the development of skills and knowledge on scientific research. This is expected to contribute to an increase in research indicators at a national, Latin American and global level, also achieving an increase in the country's scientific production with the participation of higher education students.

Methodology

The aim of this investigation is learning about the Peruvian undergraduate student's perception of scientific research and use a method to improve their knowledge in this field. It is a descriptive study by virtue of identifying knowledge and behavior of students toward research and it is also quasi- experimental research as it seeks to define the impact of the Scientific Research Training Exercise on the behavior and knowledge of the students in an experimental group.

Sample

First, the approval of participating university committee was obtained to do the exercise and the signed consent of each participant afterwards. The research sample consisted of 400 students from one Peruvian university, evaluated during the academic August-December 2018 period. The recommendation of García and Magaz (2009) suggesting that research with a sample of 150 participants is suitable was considered.

Inclusion criteria

The invitation to participate was open to all students; however, the inclusion criteria were that students must have passed the subjects of research methodology I and II, and must be actively attending university. After 400 students who met these criteria were chosen, they were explained what the intervention consisted of. Students were required to participate voluntarily, and the first 200 students who volunteered to participate formed the experimental group (EG). Once the two groups were formed, the chi square test was performed to verify that both groups were homogeneous in terms of the semester they were in at that time, sex and age. There were no significant differences between the two groups ($x2 = 1.012$; $p> 0.05$).

Procedure

The study is divided into three phases:

First Phase

TheEscala de ActitudHacia la Investigación (EACIN)-Scale of perspectives towards research - EACIN in Spanish- developed and used by de Becerra, Martínez &Novoa, (2016) was replicated and applied to find out about the perceptions and aptitudes of the undergraduate students regarding research. The contents were validated by eight experts and reliability was calculated with Combach's Alpha, with a 0.854 and –according to

George and Mallery (2003, p. 231)– the survey is deemed acceptable from 0.7. Despite being relatively new, the citations of this instrument have progressively increased.

EACIN has thirty-four (34) items distributed in three areas namely, emotional, cognitive, and behavioral. The items were measured using a Likert-type scale from 0 to 4 where 0 is strongly disagree; 1 disagree; 2 neither agree nor disagree; 3 agree, and 4 strongly agree. It is essential to consider the direction of the items as it has a bearing in the objectivity of the assessed trait, to achieve a correct qualification and subsequent exact score of the variable in question. The positive items were: 1, 2, 3, 11, 24, 26, 4, 12, 27, 13, 28, 6, 29, 14, 30, 15, 31, 32, 8, 16, 18, 19, 20, and 21;

and the negative: 10, 22, 23, 25, 5, 7, 31, 9, 17, 33, and 34. It is noteworthy to make clear and set the polarity or direction of each item because this leads to its interpretation and allocation of values to be fully opposed if negative; if the student marked 4, the value allocated will be 0, if 3 was marked, the value will be 1, if 2 was marked it will remain as 2, for 1 it will be 3, and for 0 it will be 4. The final score was the result of the sum of the items multiplied by the value corresponding to each response option.

The students gave written and signed consent for the questionnaire before the pre-test. However, anonymity was kept in the submission of this work (same as in phase 3). Table 1 shows EACIN's questionnaire handed out to the students during the pre-test:

Table 1 EACIN scale used by undergraduate students from Peruvian universities

No.	Item	0	1	2	3	4
	Emotional					
1	I relate to people during research events (congresses, meetings).					
2	Scientific conversations are some of the things I like the most.					
3	I believe I have the patience to do research.					
4	I like to study to have research skills.					
5	Daily activities are no any news to me.					
6	Research is of interest to me.					
7	Scientific conversations are boring.					
8	I like to rush research-related tasks.					
9	Thinking of research demotivates me.					
Cognitive						
10	Research should not be taught at university.					
11	Every professional should learn how to do research.					
12	I think that persistence contributes to achieving goals.					
13	Research is possible if we are willing.					
14	Researching with others helps us get better results.					
15	I believe that research helps to find errors in science.					
16	It is important to me to strengthen listening capacity in research.					
17	I feel that pressing the same issue does not help in achieving goals.					
18	Without research, science would not develop, in my opinion.					
19	I think that research contributes to solving social issues.					
20	I admit that knowledge humbles people.					

21	I acknowledge that research helps in correcting common sense errors.
	Behavioral
22	Taking refresher courses is not for me.
23	It is a waste of time to consult scientific information.
24	Most things make me curious.
25	I postpone research-related issues most of the time.
26	I am up to date with current affairs.
27	I usually write to address interesting issues in depth.
28	I find myself frequently looking up scientific information.
29	I am organized in my research.
30	I get innovative ideas regarding daily issues.
31	To be honest, writing is the least I do.
32	I take any opportunity to make my work known.
33	My research activities are a mess.
34	I am the last to learn about current issues.

Second phase: training exercise

After the pre-test, both groups took a short knowledge test with five simple multiple-choice questions addressing research methodology, publication, and indexing to find out what their shortcomings regarding the issues in the training exercise were. Training continued, irrespective of their answers, following the order initially defined because planning and design were based on a group of students with basic and nearly no knowledge about research, with the idea of starting from nothing and to use any existing knowledge in favor of the effective evolution of the exercise. The intention of the test was to corroborate whether the students' knowledge increased or not at the end of the experiment.

An experienced scientific research professor trained the EG after the test. Groups of 40 students were organized, with a total of five groups. Training was done during 14 days working with a different group everyday with modules I and II, followed by evaluations the next day. This procedure was repeated with everyone everywhere until completing the exercise.

Training consisted of two modules –Research Training Program (PCI in Spanish)– and contents were set according to the core objective of this research. The following is the modules' breakdown:

Module I: Done by professor

- Basic knowledge: scientific research, structure of a scientific paper;
- Foundation knowledge: database, indexing, publishers;
- Scientific productivity impact on institutional and academic metrics;
- Scientific presentation/submission techniques;
- Definition of relevance and scientific contribution based on the algorithmic model;
- Using Scholar Google to compile Systematic Reviews references. Module II: Done by professor
- Title and abstract as first approach to knowledge;
- Highlights and keywords as digital coding base for the article;

- Bibliography optimization as a structuring instrument of the theoretical framework;
- Introduction and Discussion balance. Synthesizing strategy as a theoretical foundation;
- Qualitative methodology vs Quantitative method. Modern science experiences and impacts;
- Results and discussion;
- Effective conclusions as article closeout;
- Tips and successful cases that expedite and increase scientific productivity;
- Presentation of an example of a correctly drafted article and incorrectly developed article;
- Real-time web search using correct and incorrect keywords, as an example of a specific subject.

Training exercise evaluation

Different mechanisms were used to evaluate learning outcomes, based on the area to be assessed (knowledge, skills, behavior) with their corresponding indicators and evaluation criteria. The evaluation tools were developed according to the contents:

- Skills evaluation: many simulations were done in the classroom at the end of both modules. Eight teams were formed, each with five students to create a title; to search the web using different platforms (Scholar Google, Elsevier [Scopus], and Scielo) using five pertinent keywords that address the chosen topic; and, drafting an abstract (different for each team). The activity lasted four hours. Participation was mandatory.
- Behavior - Feedback: 90% attendance and participation in this activity are required. To correct and strengthen the simulations-related acquired knowledge, the professor and the students discussed each team's approach. The activity lasted four hours.
- Knowledge evaluation: ten multiple question-test was taken (including those used before the training exercise), with three options where only one was the correct answer. The students needed to reply 70% of the questions correctly. This was done at the end of each course.

Impact of the exercise on the perception of research (post-test)

After carrying out the pre-test and the intervention in which the EG participated, and establishing as a condition having attended the three evaluations of the training intervention, the post-test was prepared. To know the impact of the training intervention and verify its effectiveness in terms of the students' attitude towards research, it was necessary to proceed with the quasi-experimental study (pre-post-test) with the control group (CG). The same questionnaire applied before performing the intervention (pre-test) was applied after the intervention and its respective evaluations, to measure the changes experienced by the EG and thus compare them both internally and with the CG to which intervention was not performed.

Data compilation

The EACIN form with the 34 statements was handed out on paper to the students of the EG, at the beginning and at the end of the PCI. The questionnaire was handed out to the CG during that period. Once the questionnaires were collected, the data was coded in an Excel spreadsheet and were analyzed using the SPSS 24.0 package.

Results

Many references were compiled about the students' research attitudes and abilities, the perception of research of their institution, and their participation; to support and motivate the implementation of a scientific research initiative in Peruvian universities.

Normalcy test

The normalcy test was taken after the pre and post-tests results of both groups (GE, GC), to verify whether the data follows a normal distribution or not. Table 2 shows the results after analysis of the 400 data items, without specifying the group.

Table 2 Kolmogorov-Smirnov test

Scope		**Emotion to**	**Cognitive**	**Behavioral**
GE*		400	400	400
Normal parameters	Average	2.5169	2.9679	2.3133
	Dev*. Deviation	.41695	.44247	.25761
Maximum extreme differences	Absolute	.088	.196	.226
	Positive	.056	.130	.141
	Negative	-.088	-.196	-.226
Test statistics		.088	.196	.226
Asymptotic Sig*. (bilateral)		.000	.000	.000

*GE= Experimental Group

*Dev= Standard Deviation

*Sig= Significance/Significance

Table 2 illustrates the valid cases (400) and the distribution parameters, namely, the normal distribution (average and standard deviation), showing the most extreme differences between the accumulated empirical and theoretical frequencies (the largest of the positive, the smallest of the negative and the largest of the two in absolute value. The Kolmogorov-Smirnov of emotional (Z

=0.088), cognitive (Z=0.196) and behavioral (Z=0.226) statistical data results have the same values or bilateral asymptotic critical levels, namely (Sig= 0.000<0.05). The normalcy hypothesis is rejected because of the insignificant critical level value (less than 0.05) and the conclusion is that every status (emotional, cognitive, and behavioral) do not have a normal distribution.

The following is the analysis to corroborate the normalcy hypothesis separately for both groups and in both tests:

Table 3 Kolmogorov-Smirnov Test. Normalcy Analysis

Type		Group		Emotio nal	Cogniti ve	Behavio ral
Pre	Control	GE*		200	200	200
		Normal parameters	Average	2.3239	2.8962	2.2823
			Dev*. Deviation	.41286	.43285	.32728
		Maximum extreme differences	Absolute	.109	.194	.201
			Positive	.056	.067	.137
			Negative	-.109	-.194	-.201
		Test statistics		.109	.194	.201
		Asymptotic Sig*. (bilateral)		.000	.000	.000
	Experimental	GE		200	200	200

		Normal parameters	Average	2.3517	2.9062	2.2677
			Dev. Deviation	.38855	.46454	.32772
		Maximum extreme differences	Absolute	.086	.164	.244
			Positive	.046	.091	.140
			Negative	-.086	-.164	-.244
		Test statistics		.086	.164	.244
		Asymptotic Sig.(bilateral)		.001	.000	.000
Post	Control	GE		200	200	200
		Normal parameters	Average	2.3256	2.9387	2.3196
			Dev. Deviation	.44214	.40061	.31107
		Maximum extreme differences	Absolute	.069	.188	.186
			Positive	.050	.066	.106
			Negative	-.069	-.188	-.186
		Test statistics		.069	.188	.186
		Asymptotic Sig.(bilateral)		.022	.000	.000
	Experimental	GE		200	200	200
		Normal parameters	Average	2.6822	3.0296	2.3588
			Dev. Deviation	.37775	.41122	.14658
		Maximum extreme differences	Absolute	.104	.306	.173
			Positive	.075	.195	.127
			Negative	-.104	-.306	-.173
		Test statistics		.104	.306	.173
		Asymptotic Sig.(bilateral)		.000	.000	.000

*GE= Experimental Group

*Dev= Standard Deviation

*Sig= Significance/Significance

After the normalcy tests of both groups, it was confirmed that the sample does not meet the necessary requirements to use parameters analysis. Null hypothesis was rejected after interpreting data because the p-value did not exceed 0.05, corroborating that the variable does not follow a normal distribution. Mann-Whitney's U test was used as the most suitable non-parameter test.

Learning Outcomes

With 100% participation of the sample (EG=200) the students' applied knowledge test score was higher than 80%. Every student passed the evaluation.

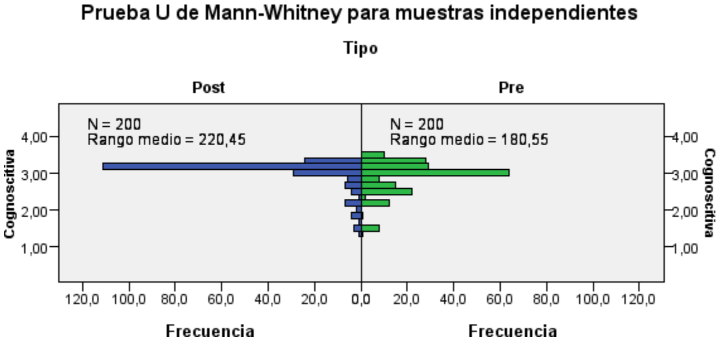
Competence evaluation (behavior). The 200 students exceeded 90% attendance criterion of classroom presentations and discussions.

Skills evaluation: 100% participated in classroom simulations. Two hypotheses were set:

- Ho (null): no significant changes of students because of the exercise.
- H1 (null): significant changes of students because of the exercise.

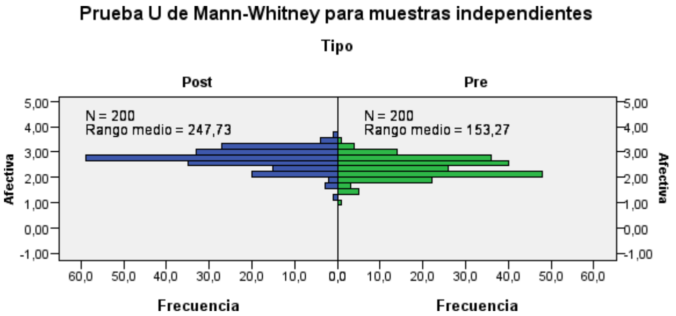
Based on the results, the null hypothesis is rejected in EG; the average test score rose after the training. The null hypothesis in CG cannot be rejected based on the results, because it cannot be confirmed that there was a significant rise in pre and post-test average scores.

The difference in EG pre and post-test results is shown below:



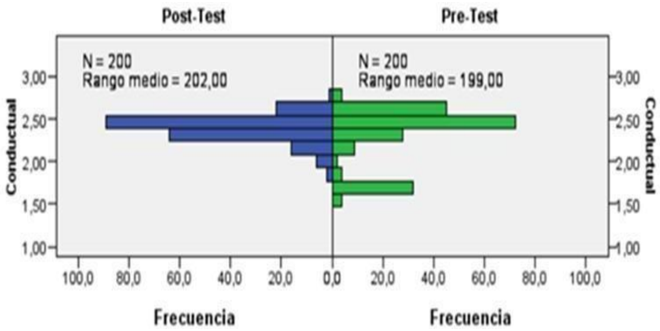
N*= Sample Number

Fig. 1 Mann-Whitney Emotional U test



N*= Sample Number

Fig. 2 Mann-Whitney Cognitive U test



N*= Sample Number

Fig. 3 Mann-Whitney Behavioral U test

There were no significant statistical differences before and after the exercise regarding behavior. The significance level was 0.793>.05 (5% significance), therefore, the null hypothesis cannot be rejected. Figure 3 shows the small variance between average range for both tests. Despite the lack of significant statistical results differences approximately 15% of studio sample changed their opinion about item 23: "It is a waste of time to consult scientific information"; in the pre-test 70 students agreed and 59 strongly agreed. In the post-test, 55 students agreed and 45 strongly agreed. In the post-test, there was a 20% drop of the students that agreed to the statement in 25 "I postpone research-related issues most of the time" in the pre-test. After the training, in the post-test, 20% more of the surveyed sample agreed with the statement in 33 "My research activities are a mess".

According to the hypotheses raised about the training intervention carried out, the following was obtained:

For the CG, asymptotic significances for the different dimensions were as follows: affective: .856; cognitive: .370; Behavioral: .204. All of them exceeded the significance level of .05, which implies retaining the null hypothesis: the intervention did not produce significant changes in the students.

On the other hand, for the EG, asymptotic significances for the different dimensions were as follows: affective: .000; cognitive: .001; Behavioral: .793. The affective and cognitive dimensions did not exceed the significance level of .05, which implies rejecting the null hypothesis; while for the behavioral dimension, with an asymptotic significance greater than .05, the null hypothesis of the study is retained.

Discussion

Our initial hypothesis stated that a formative intervention would help improve research knowledge, skills, and competencies of Peruvian students; and change their motivation, perspective, and perceptions towards research. It is important to highlight that the sample of this study was obtained from universities where the medical degree is not taught, and when performing the literature review, it was found that the largest number of articles that evaluate the skills and perception of students to carry out scientific research arefocused on medical students (Díaz et al. 2008; Arrollo et al. 2008; Osada et al.2010; Ochoa-Vigo, Bello Vidal, Villanueva Benites, Ruiz-Garay& Manrique Borjas, 2016; Sánchez-Carlessi 2017) This may be related to the fact that in Peruscientific production is mostly limited to the area of medicine (Scimago Journal and Country Rank 2020). The students who participated in this study stated that the preparation they received from the university was not oriented to scientific research, emphasizing that for them, undergraduate research was limited to the completion of their thesis to obtain the professional degree. Although scientific research in Peru is more developed in medical careers, in an investigation carried out by Molina-Ordóñez et al. (2008), students of this career stated that the scientific research preparation received in the university was deficient and that their knowledge in the scientific area was greater than that provided by the university; however, they indicated that they belonged to scientific research societies. Indeed, in Peru (Miyahira Arakaki2009) and in the rest of Latin America (Mayta-Tristánet al. 2013) there are scientific research societies of medical students. Díaz et al. (2008) confirm that there is a directly proportional relationship between the positive attitude towards research, the level of knowledge and the fact of being part of a research group. After carrying out the intervention, according to the results of the post-test, the motivation of the students to carry out scientific research increased, and they showed enthusiasm for the tools provided in the dynamics. Coinciding again with Molina-Ordoñez et al. (2008), sample students stated that their information search skills were not taught at the university, but were acquired by themselves. Given this situation, it is necessary that scientific research is integrated more radically in the training of undergraduate students in Peruvian universities, allowing them to develop skills and capacities related to research and to the process of scientific publication (Sánchez-Carlessi 2017).

Regarding the acquisition of skills and competences through the formative intervention, these were evaluated through tests and simulations carried out in the classroom. Some of the acquired competences are described in the sections below.

Scientific research acquired knowledge

Participants increased their scientific research knowledge stating that it is not the sole and exclusive task of professional educators. A smaller number of students –compared to the pre-test– in the post-test agreed with the statement in 11 "Every professional should learn how to do research." In the competencies and behavior evaluation, the students initially perceived research as their thesis work to be awarded the degree; they also mentioned that the knowledge they had was merely bad quality methods without information on resources for quality research and the scientific publication process. However, participants showed interest in applying their acquired knowledge that –together with a methodological effort and support from research professors – could have positive results in students participating in scientific research. This coincides with the results obtained by Limniou, Mansfield & Petichakis (2019) and Hu et al. (2007), who affirm that a good professor-student relationship plays an important role in research activities, given that students value this interaction positively in their learning. The lessons learned support the results of Jasko, Wood, & Schwartz (2003); Montanéand Vidal (2007), Osada et al. (2010) who affirm that there are many research ideas from students that have not been developed, even unfinished articles.

Knowledge and database management to search for information, indexing, and publishers

One hundred percent (100%) of the EG correctly replied 80% of the questions. Every participant was involved in class simulation searching the various database engines; they had good search command, thus supporting the written evaluation results. The students said that they learned about search platforms, publisher, and indexing saying, for example "I only used Google to do my work, I did not know about Google scholar "; I did not know how the research world worked and it is a whole entire world... in fact, I did not know that there were search engines for magazines only, with rankings"; "after this training is good to know I can use Google scholar for research using exact and validated information because most articles are short"; it is excellent knowing how to use keywords, it helps accurate searches." These are some of the answers resulting from class simulations. It is imperative to teach indexing platforms in the classroom, so that the student already knows about their existence and, above all, about their great usefulness. The potential of bibliographic searches is not used,despite publishing platforms development and user increase, because of the lack of information on research contribution to society (Osada et al. 2010).

How to write a research article

After the training and despite good command of search engines using the correct keywords to develop the title; the students lacked during drafting the research article abstract. They were slightly confused in discerning and differentiating some contents that should be in one section instead of another when it was necessary to encompass the information; namely, background, aim, methodology, results, and conclusions. Specially detecting the difference between results and conclusions. This shows weak education in research methodology subjects in their educational centers. Indeed, the students stated that the University program did not provide them with information on how to prepare a scientific article. The reason for this was reported by Molina- Ordóñez et al. (2008), who argued that, like undergraduate students, university professors also have little editorial knowledge, given that the rate of scientific publication of professors is very low. This limitation of scientific research in the undergraduate field was also detected by Mayta-Tristán et al. (2013), who reported that undergraduate students in Latin America perceived the research training received at the university as deficient. Likewise, Molina et al. (2008) showed that more than 60% of the students indicated that the training received regarding scientific publication was null. Along these same lines, Arrollo et al. (2008) found that undergraduate students only related to research through the development of their thesis as a graduation requirement, also stressing the difficulty in their conception and its low quality, because of the absence of previous experience on research. To this must be added the reality that, in many universities, the thesis preparation stage is nothing more than a complicated ascent through a road of obstacles that the same university imposes on the student, such as the exaggerated improvements required by subjective tutors. Instead, thesis elaboration should be the first step for the student to feel motivated to enter the research world (Osada et al.2010). The authors also mentioned that one of the limitations of students to investigate is not having the support of professors. However, after the intervention the class results for this evaluation were higher than the minimum pass requirement; the average was 7.1 out of 10.

Impact on research perception

The impact of the training exercise on the students' research perception increased motivation to undertake research. Some changes in the answers to the pre and post-test statements are: "Researching with others helps us to get better results", there was an 25% increase in agreement; "It is a waste of time to consult scientific information", a 15% increase in disagreement; "I postpone research-related issues most of the time", 20% increase in disagreement. There was an option of "neither agree nor disagree" that significantly dropped in the post-test, in favor of the research position. Analyzing "Researching with others helps us to get better results" once again, 130 students were in favor in the pre-test, while 55 were impartial. The post-test showed 179 students agreeing, of which 37 were impartial. In the post-test 55 students neither agreed or disagreed and changed to 18 students (the remaining 12 students who disagreed with the statement in the pre-test, agreed in the post-test).

Impact on own research perception

According to student participation in the training exercise, they initially had a slightly wrong perception about scientific research, as well as their pertinent knowledge –as shown in the initial evaluation– were limited; this was reflected in some of the pre-test items. However, after training, in the post-test results there was a raise in their motivation to do scientific research. For example, their position changed regarding the statements of "I believe I have the patience to do research"; "I like to study to have research skills"; "Research is of interest to me", for which there was an increase in agreement of13%, 22%, and 20% respectively. "My research activities are a mess" also increased by 20% of the students that disagreed; during the feedback session there were answers such as "I know that when researching my ideas are scattered and look a bit messy, however, I am excited to learn how to put them in order and design better research". Díaz et al. (2008) in their study have a positive position towards research described by students participating in our study, "it is not necessary to be gifted to do research." This motivation increase for research could positively impact scientific research in undergraduate studies at universities, creating change thanks to the contribution and attitude of the students who are taking action to foster publishing from undergraduate level (Huamaní, Chávez-Solís, Domínguez-Haro& Solano-Aldana, 2007). Other positive responses from the students were that they believe that research helps in finding mistakes in science and without it, science would not develop. Together with the students' motivation because of the training exercise, these results are encouraging.

Impact on university research education perception

Arrollo et al. (2008) claim that students from many Peruvian universities say that they do not plan time for research and regard it as an extra-curricular activity. However, the fact that the students changed their mind regarding "I feel that research should not be taught at university"; initially and before the training, the pre-test results agreed with Arrollo; however, this improved after the exercise. There are factors that should be strategically considered to improve the student's position about research; for example, motivation, involvement, current research, and reflection are four elements related to the students' beliefs about researching (Visser-Wijnveenet al. 2016).

Conclusions

The methodology used to measure the impact of a research formative intervention on perception, motivation and research skills in Peruvian undergraduate students had positive results. These were evidenced in the changes in the pre- and post-test of the EG, in which statistically significant differences were observed in two of its studied dimensions (affective and cognitive) as well as descriptive differences in the behavioral dimension. No significant differences were observed for the CG.

One of the main weaknesses of Peruvian students in research is that they lack training in research methodology. It was clear from the pre-test that the students had the wrong perception of their research responsibility and/or right. After the formative intervention with modules and explanation about the importance of research using statistics, showing them its use and benefits, it was possible to drive their motivation –as proven by the post-test results. It is also extremely important that they acquired skills and knowledge as per the grades obtained in the final test.

This research is one of the few carried out in Peru (if not the only one) to measure the attitudes and motivation of students towards scientific research, focusing on undergraduate students from different careers except medicine, given that according to the bibliography consulted, published studies mostly focus on medical students. Through this research, it is suggested to the Peruvian universities the implementation of scientific research in their study programs as a culture, and the promotion and incentive for their professors to participate in scientific research projects that involve their students so that they learn and progressively co-author scientific publications, all with the aim of increasing the country's scientific production. This study opens the doors to new research that assesses student participation in developing scientific articles. In fact, this study can be repeated with the same sample to assess if there was progress in their participation or contribution to scientific publications.

Implications of research

Our results suggest that implementing this intervention methodology in higher education institutions allows detecting the level of knowledge and abilities of students on how to prepare scientific articles, while it also increases knowledge about research and encourages young students to participate in the development of research activities. This intervention model allowed us to know students' perception and with it, elaborate suggestions for the modification of Peruvian academic programs to strengthen research, thus contributing to the increase of scientific production both in Peru and in other countries that decide to implement it. Regarding future research, it would be appropriate to replicate this work, carrying out a longer evaluation of the study sample in which it can be known whether the students make any kind of scientific contribution to a publication.

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