Research projects and publications of undergraduate students. A success case at an Ecuadorian university

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Abstract. This study analyzes the proposal of a strategy for the development of research projects and publications of students in the last year of the Computer Engineering program at the Universidad Politécnica Salesiana, in the city of Guayaquil, Ecuador, applied from 2018 to the present. Quantitative descriptive research with a longitudinal approach is developed. The experience assumes that involving trainees in authentic experiences (where external peer experts will be the evaluators of the work done) is the key to obtaining valid results in a context of generation and dissemination of knowledge. The results show that the proposed process creates an effective system for students to learn to design and apply an applied research project, as well as to produce a scientific product for publication in indexed journals or conferences. The process also involves close accompaniment by the tutoring professor which, together with the phases and requirements described in this work, is a key factor in the training of university students as novice researchers and leads to a relevant experience, with outstanding publications and a favorable perception on the part of the participating students and professor.

Keywords: Training of researchers, Research project, Training of scientific personnel

1 Introduction

One of the recent topics of debate in the educational field is the learning experience of undergraduate students for the development of a scientific research proposal (Stan et al., 2023). The interest is focused on understanding the best pedagogical strategies and procedures for students to experience research processes, accompanied by tutors, and to develop the necessary skills to design research proposals that may even become publications (Thiem et al., 2023).

Current Ecuadorian regulations allow universities to choose the development of a research project as a degree modality for all degree programs. In the case of the Universidad Politécnica Salesiana (UPS, 2018), this process is developed in the so-called "Degree Units" that receive the student's proposal and facilitate the accompaniment by means of an assigned tutor (Cadena et al., 2017). From 2018 to the present (April 2023), the authors of this study have designed and implemented a formative strategy for re-

search with students in the last year of the Computer Engineering degree that has obtained as a result that students who develop an applied research project achieve its subsequent publication in journals or conference proceedings indexed in reference databases.

2 Theoretical Framework

Ideally, an organizational, planned and structured model by higher education institutions establishes clear processes for defining the trajectory and completion of a student's degree and research development processes, taking into account administrative and academic management (Cadena et al., 2017; Ferrer & Carbonell, 2014; Llerena-Izquierdo & Ayala-Carabajo, 2021b; Situmorang et al., 2023). However, the attention and control of the organizational, regulatory and/or administrative nature of the degree does not guarantee that students will develop project design and scientific writing skills conducive to research competence (Freire et al., 2016; Molina Jaén et al., 2020; Rubio et al., 2018).

Cooperative learning is a strategy that favors the development of scientific research skills (Granados et al., 2007; Sánchez et al., 2021). Planning four stages in the development of the research process (diagnosis, planning, execution, and evaluation) favors the development of research skills in undergraduate students (Moreira-Moreira et al., 2021; Sánchez et al., 2021). In addition, developing papers of an empirical nature, with an emphasis on academic writing, is an effective formative research strategy (Londero & del Valle Soria, 2021). At the same time, one of the key elements of research training is its connection with one's own professional activity (Estrada Molina, 2014; Martínez-Plumed & Hernández-Orallo, 2022).

3 Method

This is a longitudinal case study with a quantitative approach. The survey technique is used to know the students' perception of the strategy developed.

The strategy is developed in five phases over an average of eleven months. Specifically, phases one through three cover the five months prior to the student's entry into the degree process (Unit), while phases four and five take place during the semester corresponding to the degree.

In the first phase, students present their proposals of topics in Computer Science. The professor provides guidance in defining the scope, purpose and usefulness of the study, as well as the justification for the choice of topics from the literature review. The general and specific objectives are established, as well as the hypotheses or research questions. An initial research plan is developed.

In the second phase, the literature was reviewed using the PRISMA model and an advanced search (with inclusions, exclusions and logical combinations) in Scopus and Web of Science.

In the third phase, the problem is defined and an introduction to the project is developed. The pre-project document is prepared to formalize the application for the degree option and the experimentation (if applicable) begins.

In the fourth phase, methods and techniques are applied to collect data. The data are analyzed, and the drafting of the results found begins. Conclusions are drawn.

In the fifth phase, the data obtained by the students are contrasted with those of other works and the discussion is raised according to the established hypotheses or research questions. In this phase, the tutor determines the congress or indexed journal to continue with the process of sending the finished product, accompanying the student to meet the requirements according to the area of research and the student's profile.

4 Results

The results of this research skills training methodology are reflected in the publication of 23 final degree papers indexed in Latindex, Scopus and Web of Science, from 2018 to the first quarter of 2023, (see Fig. 1).

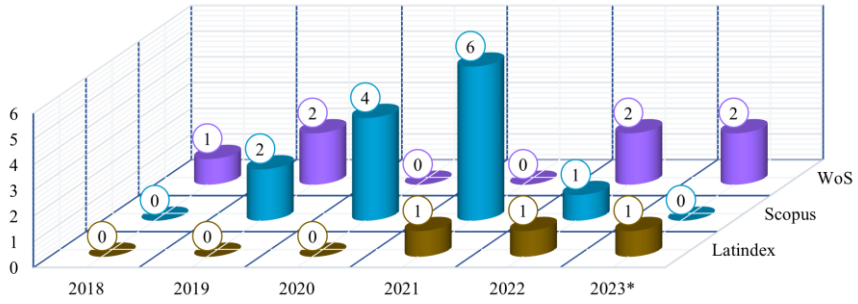

Fig. 1. Number of publications per year and by indexing following the research methodology for undergraduate students, as of April 2023.

In addition, a total of 27 success stories have been achieved, 14 students are male and 13 are female students (see Fig. 2).

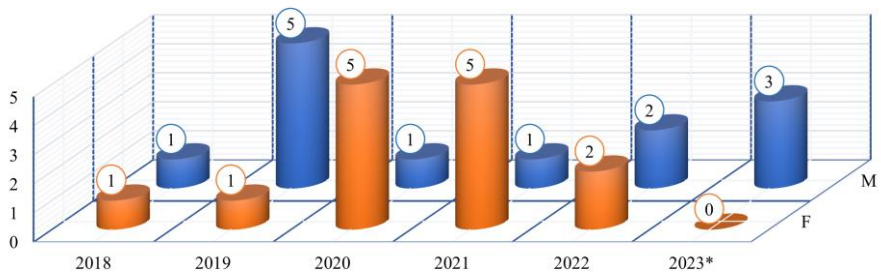

Fig. 2. Number of participating students by gender and by year following the undergraduate research methodology, as of April 2023.

A survey addressed to the participants at the end of the process made it possible to identify their perception of the proposed methodology. They were asked how adequate the methodology is developed by the tutor. The results were 15% very adequate and 85% extremely adequate.
They were also asked about their agreement with the experience, obtaining 4% agree and 96% totally agree. This shows that the methodological process achieves a high level of acceptance among the participants, (see Fig. 3).

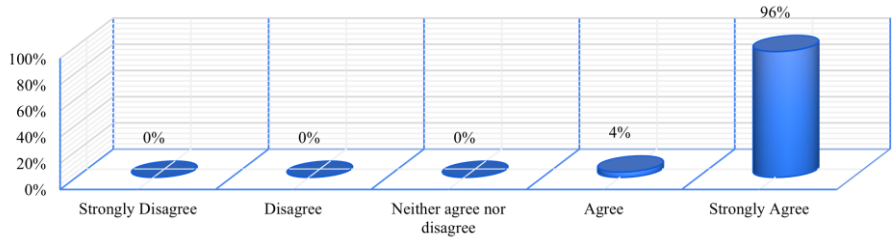

Fig. 3. Percentage of participants who indicate that they agree with finishing their undergraduate studies with a research work experience as a degree option.

Finally, the participants were asked if they consider that they agree that the tutor's support has contributed to generate new competencies in the participant. The results were 11% agree and 89% totally agree.

5 Discussion

The formation of research competencies entails a set of conditions that can be raised in undergraduate training (Stan et al., 2023). These conditions are those included in the strategy under study. Ordinarily, it will require direct instruction by the tutor and scientifically relevant work is expected as a result (Thiem et al., 2023) and related to the professional field (Estrada Molina, 2014). It is possible for undergraduate students to contribute scientific research papers that can be presented to the academic community with results validated by academic peers under demanding standards (Llerena-Izquierdo & Ayala-Carabajo, 2022). Experience shows that there are professors who can develop effective methodological processes for their trainees to achieve skills at the university stage that can culminate in publishable works (Llerena-Izquierdo & Ayala-Carabajo, 2021a).

6 Conclusions

A training strategy in research and academic writing has been proposed, which from 2018 to the present, has proven to be effective and valuable to place students in an authentic learning experience, both process and the requirements of designing a research project and dissemination of its results in the form of a paper or scientific article, presented or published in a conference or indexed journal, respectively. The keys to the success of this strategy are: the relatively long time (eleven months) it takes; the close and expert accompaniment of a research professor in the area; the use of techniques such as the PRISMA systematic review; the involvement in practices with demanding standards of scientific writing, such as publication in indexed journals; the fact that the problems addressed belong to the real work context; the systematic and organized process that has been perfected throughout the cycles.

Limitations and Future Research

The application of the methodology has corresponded to a particular professor over 5 years and will need to be applied by other professors in different contexts and with different groups of students. The students, as well as the tutor (co-author of this study) perceive positively the process developed as an experience replicable to other higher education institutions: it will have to be assessed whether the success of the strategy depends on the same or on other contextual or subjective factors, to be studied.

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