REVIEW ARTICLE

Research in schools of health sciences

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ABSTRACT

Research stands as a fundamental pillar that recognizes the university as an entity of institutional and social relevance. This statement is particularly true in the field of health sciences, where educational institutions are expected not only to generate knowledge for the benefit of society but also to shape individuals capable of immersing themselves in research and strengthening this vital premise.

In this context, intricate concepts that outline the nature and purpose of research in the academia emerge. Scientific research, on the one hand, arises as the driving force behind the advancement of knowledge, emphasizing rigorous and systematic methods to unravel the mysteries of reality. On the other hand, research training stands as a pivotal educational vehicle for nurturing analytical and curious minds, providing future professionals with the necessary tools to inquire and contribute to scientific progress. Similarly, formative research, although less known, plays a crucial role in integrating research into the learning experience, which fosters critical thinking skills and problem-solving abilities from early stages.

In this educational and research journey, various actors and components take center stage. Research centers arise as fundamental pillars, as they provide the conducive environment to interdisciplinary collaboration and development of innovative ideas. Educators, on their part, play the role of counselors and mentors by sharing their experience and knowledge with the new generations of professionals. Furthermore, extracurricular or nonacademic activities in the area of research emerge as fertile grounds for the expansion of intellectual horizons, offering spaces for creative exploration and practical application of the knowledge acquired by students.

However, these concepts and components are not free of challenges and controversies when integrating into the academic programs. Implementing these approaches at the undergraduate and graduate levels requires an in-depth analysis of their specific objectives and goals. Discussions regarding the balance of time and resources devoted to research versus other curricular aspects remain a constant.

This review aims to accurately outline and define the concepts of scientific research, research training and formative research, as well as to highlight the leading role played by research centers, educators and extracurricular activities in shaping academic programs in the field of health sciences.

Keywords: Education, Medical; Students, Medical; Professional Competence; Research; Teaching; Research Design (Source: MeSH NLM).

INTRODUCTION

The university, at its core, assumes several commitments to society. Among these are the training of highly qualified professionals, the generation and transfer of essential knowledge for economic and social advancement, as well as the active promotion of culture, art and humanities that contribute to the collective well-being. Thus, the university's mission is based on three fundamental pillars: education, research and social projection. Although there has been an increased focus on research in recent years, the premise of performing these functions in a balanced and convergent manner is maintained [(1)].

Schools focused on health sciences are mainly aimed at the training of professionals committed to the prevention, diagnosis and treatment of diseases. These include the training of physicians, odontologists, pharmacists, nurses, obstetricians (midwives), technologists, nutritionists and psychologists. Regardless of the specialty, it is essential that all these professionals have a solid research background

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so that they are prepared to face the challenges of the contemporary world [2].

Research is undoubtedly the lever for scientific and medical progress. It is included in both the training of health professionals and the search for solutions to meet and satisfy the emerging needs of society. In fact, it is a cross-cutting element in university activity [3]. The challenges in the field of health are continually evolving, emphasizing the imperative need for innovative solutions derived from research. In this task, universities and health professionals play a critical role and should be at the forefront of these efforts [4].

An outstanding university education—the one that shapes individuals into competent, ethical professionals capable of enriching society—cannot be achieved without research. Additionally, it should encompass adequate facilities, professors with expertise and relevant academic strategies [5].

In short, an outstanding university education is inconceivable without research. Thus, it is necessary to recognize and value the different aspects of research in the academic environment: scientific research, formative research and research training. The aim of this review is to highlight the importance of these concepts at the different university education levels.

SEARCH STRATEGY

A non-systematic literature search was conducted across PubMed, SciELO and Google Scholar without time constraints, encompassing both Spanish and English languages. Publications were selected based on the author's criteria, focusing on the relevance to their study objectives. The search terms included "Medical Education," "Research," "Formative Research," "Research Skills," "Health Sciences," "Mentoring" and "Learning." Additionally, potential relevant articles were identified by analyzing references cited in other publications.

RESEARCH TRAINING

Research training (RT) consists of a series of activities embedded in curriculum subjects or modules, aimed at developing research skills in students [6,7].

It is crucial for all professionals in the field of health sciences to have the skills and aptitude to identify problems, design research to solve such problems and to communicate their findings, either through written reports or oral presentations. This recommendation made by the World Federation for Medical Education (WFME) [8] serves as a benchmark for the graduation profile of medical students and extends to other health sciences professions.

It is important to emphasize that the main purpose of undergraduate education in health sciences disciplines is not to train researchers. Rather, it is to fulfill the aforementioned skills and focus on the training of professionals to assist in the health-disease process with critical thinking, capable of analyzing and conducting research when needed and applying it effectively in their healthcare practice [9].

It is essential to foster a research-oriented attitude among health sciences students, a concept referred to as "research mindset." The diagnostic process shares similarities with the approaches inherent to scientific research. This attitude should inspire them to consider each patient as a challenge, conducting assessments that lead to the formulation of verifiable hypotheses [10].

While it is true that there is a shortage of research physicians, this deficiency is not necessarily due to inadequate training. Instead, it is usually related to prioritization of clinical care responsibilities, as well as personal financial and salary considerations [11]. According to a recent report by Consejo Nacional de Ciencia, Tecnología e Innovación Tecnológica (CONCYTEC – National Council of Science, Technology and Technological Innovation), there are 7,088 registered researchers in Peru, with 1,622 of them specializing in medical and health sciences. These researchers are engaged in studies covering clinical and basic medicine, biotechnology and health sciences [12].

It is imperative to incorporate RT into the curriculum. Regardless of the subjects or modules comprising RT, students should sequentially acquire competencies in epistemology, literature search, data analysis and interpretation (statistics), research design, critical reading, research project development, scientific writing, publication process and scientific integrity (Figure 1). The number of subjects, academic credits, teaching strategies and their weight in the curriculum will vary depending on each institution and are always subject to debate.

In the Latin American context, many medical students perceive their research and publication training as inadequate [13]. Conventional education often involves courses such as Research Methodology or Thesis Seminar, which may not always cover all the essential topics. When employing a traditional teacher-centered approach—which includes lectures, infrequent practical sessions and lacks an academic product for the final grade—the acquisition of research skills is often hindered [14]. This deficiency may contribute to the dissatisfaction expressed by most students regarding their learning experience in research methods, literature search, scientific writing, critical reading and publication process [15].

The situation is further complicated if educators lack

experience in publishing [16]. Additionally, the absence of an integrated approach, linking research to the clinical or epidemiological context, poses a challenge that becomes more noticeable when educators are not health sciences professionals or researchers.

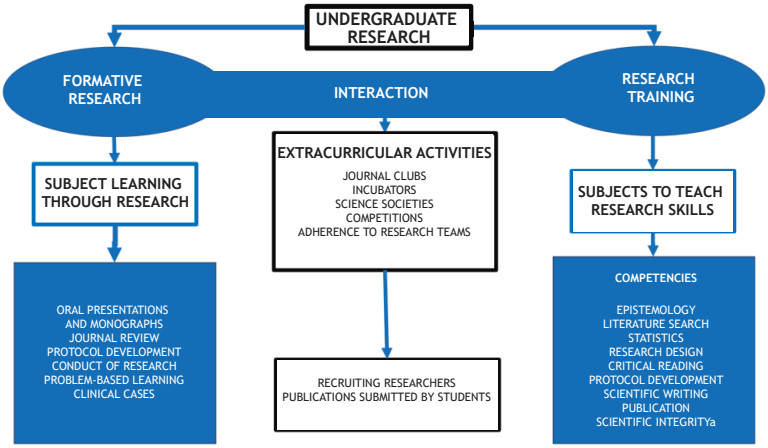

Figure 1. Research teaching at the undergraduate level in a school of health sciences. The figure presents the objective and strategies of formative research, the objective and competencies that students should acquire in research training, and the extracurricular activities that can be developed in the field of research and its objectives.

FORMATIVE RESEARCH AT THE UNDERGRADUATE LEVEL

Formative research (FR) involves learning a discipline or subject through research, enabling students to actively engage with the topics of study and apply acquired knowledge in RT subjects [17,18]. It aligns with innovative pedagogical approaches based on constructivism and student-centered learning, within the framework of discovery learning [19].

By conducting research on a smaller scale, FR promotes the development of critical thinking, the skills to analyze scientific literature and formulate research questions based on real-world observations [20]. The aim is not necessarily to produce publishable results.

At the undergraduate level, research is an essential component of the educational strategy. Instead of focusing on the creation of new knowledge, its main objective is to motivate students to apply their learning from RT subjects in research that allows them to enrich the learning process in a specific field [21].

Therefore, FR addresses topics aligned with the objectives of the relevant subjects, in contrast to research conducted at master's, doctoral and research institute programs, which focuses on generating new knowledge.

Documentary research, which includes the search, reading, analysis and interpretation of publications, serves as a basic and common element in the FR modalities. Therefore, this strategy requires guidance and supervision from professors, as well as active participation of students [22].

FR has several modalities:

1. **Oral presentations and monographs:** Documentary research supports the preparation of oral presentations and monographs, encouraging critical analysis of scientific literature, verbal communication and scientific writing. However, caution must be exercised to avoid breaches of academic integrity [23].

2. **Journal review or journal club:** Through the search and critical analysis of scientific articles, cognitive skills and critical thinking are strengthened while becoming familiar with evidence-based medicine (EBM) [24]. It has been widely used at the graduate level and underutilized at the undergraduate level. It is especially valuable in clinical settings as well as in the basic sciences, when reviewing topics of interest proposed by the professor in each subject or module. It necessarily requires adequately trained educators [25, 26].

3. **Design and conduct of research:** The conduct of qualitative or quantitative research, whether individually or in groups, across various areas such as basic sciences, clinical practice or public health is proposed. Consequently, research plans or projects are formulated, which may or may not be implemented, but aim to encourage students to systematize the problem through the development of critical thinking. This

approach could be interdisciplinary and collaborative, involving multiple subjects.

4. **Problem-based learning (PBL):** This pedagogical approach, adaptable to entire subjects or specific topics, encourages group work, problem identification, information search and analysis, and collective discussion to arrive at solutions. By engaging in this methodology, students develop essential skills for their future professional practice [27,28].

5. **Clinical cases:** They integrate clinical training with documentary research, as long as they are complex cases that require thorough analysis by the student. This should not be confused with the presentation of typical cases or models [29].

Certainly, RT courses provide the foundations, while FR represents the tangible and practical application of such principles. These two approaches are intrinsic, complement each other and are inseparable. Hence, professionals may experience conceptual confusion when engaging with these areas.

The synergy or interaction between FR and RT is essential to nurture research skills. The FR strategy could not be effectively employed without a solid knowledge of research principles [30]. This integration can originate from the school's curriculum, as proposed by Romaní et al. [31].

For example, consider the EBM teaching model, where both instructors and students need to have research skills acquired in RT subjects to locate, analyze and evaluate scientific articles, with the purpose of applying them in professional practice and assimilating knowledge specific to their field of study [32].

Therefore, undergraduate research aims not only to generate new knowledge but also to reinforce learning and skills development in students. FR is presented as a highly relevant educational strategy to shape health sciences professionals with strong critical thinking and research skills.

EXTRACURRICULAR ACTIVITIES

Extracurricular activities are those that occur outside the regular curriculum and aim to complement the student's training in specific areas. Although not officially part of the curriculum, these activities play a vital role in the holistic development of students [33,34]. In the field of research, these activities specifically seek to encourage and channel students' interest toward the generation and dissemination of knowledge.

Research-related extracurricular activities aim to provide students with additional opportunities to enhance their research skills, broaden their knowledge and engage in meaningful experiences beyond the classroom. Their goal is to strengthen research skills in interested and motivated students and to provide a starting point for those aspiring to pursue research as their primary professional activity, ultimately becoming researchers [35,36].

It is crucial for institutional leaders to support such activities to ensure the achievement of the proposed objectives and to eliminate barriers that may hinder students' participation in research [2].

It is in this context that the following extracurricular activities, linked to research and promotable in a school of health sciences, are described:

1. **Critical reading club or journal club:** This group consists of students who convene periodically, either weekly or monthly, to critically assess the validity and applicability of articles from scientific journals. At the same time, it serves as idea generator to develop future research [37]. Ruíz García et al. [38] propose a decalogue for the success of these meetings, including mandatory attendance, financial support from the institution and a formal agenda, among others.

2. **Research incubators:** These groups, formed by students led by professors interested in conducting research in specific areas of knowledge, collaborate to develop research projects, explore topics of interest, promote critical thinking and foster knowledge generation in an academic setting. Research incubators provide students opportunities to engage in research activities from early stages of their academic training. Participation in research incubators facilitates the development of research skills and involves students in regular meetings, discussions, workshops and joint projects. They also provide a platform for students to present their research findings, exchange knowledge and receive feedback from peers and professors. These groups serve as important tools for cultivating a research culture in educational institutions and inspiring students to explore and contribute to advancement of knowledge across various disciplines [39,40].

3. **Support for student science societies:** These organizations, established in some medical schools for several years, bring together research-motivated students to enhance their skills and are organized for that purpose. The efficacy of these societies is reflected in the number of publications associated with their members [41]. Moreover, the progression of former students into roles of university researchers and professors, with a consistent presence in high-impact journals, is evident [42-44].

4. **Linkage with researchers and professors:** Serving as research assistants allows students to learn from experienced professionals, gaining practical skills and specific knowledge of the research area [45].

SCIENTIFIC RESEARCH AND RESEARCH INSTITUTES

Scientific research is the methodical and systematic process that facilitates the generation of new knowledge, contributing to the overall development of a country. Universities fulfill this role through their research institutes or centers. These entities are tasked with the vital mission of being the primary generators of innovative knowledge, thus serving as the epicenter of research activity within a university.

In other words, research institutes, together with doctoral and master's programs, play an essential role in driving scientific research within a school of health sciences. Their effectiveness and contribution are mainly evidenced by the publication of research outcomes in prestigious scientific journals and their presentation in high-profile events (Figure 2).

Within these institutes, it is essential for research professors to serve as full-time professors, prioritizing their dedication to research activities. According to Law 30220, the teaching load for instructional activities should be limited to one course per year [46], not exceeding 10 hours per week.

The integration of these research professors with graduate academic programs, such as master's and doctoral programs, fosters a fruitful synergy, although it may limit their interaction with undergraduate students, potentially leading to alienation from this student population [47].

Nevertheless, there is a valuable opportunity for institutes to involve undergraduate students in research projects. This inclusion not only enriches the academic experience of these young individuals but also strengthens the research community within the institution.

It is undeniable that research entails significant expenses, and the pursuit of high-quality research usually demands substantial investments in terms of resources, acquisitions and equipment maintenance [48]. Unfortunately, Latin American universities often lack the capacity to cover these costs. Therefore, it is essential for research at this level to be supported by external entities, such as CONCYTEC, non-governmental organizations (NGOs) and the private sector, among other key stakeholders [49]. Despite the lack of specific data on private universities, it is important to note that collaboration between public universities and the productive sector often faces limitations [50]. In this context, institutional leaders must also take on the responsibility of seeking external funding sources to advance projects.

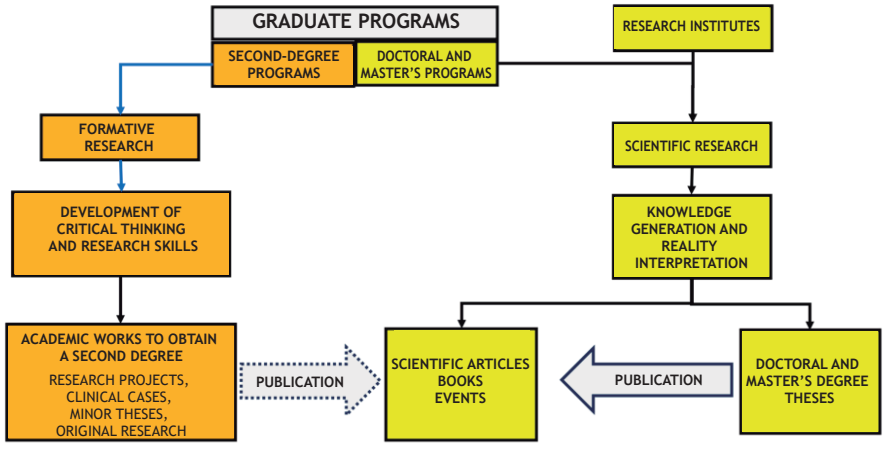

Figure 2. Research conducted within research institutes and graduate programs. Scientific research generates knowledge through research institutes and master's and doctoral programs. Additionally, FR serves as a teaching strategy in second-degree programs and their academic outputs.

SCIENTIFIC RESEARCH, GRADUATE STUDIES AND THESES

Research conducted within schools of health sciences yields different outcomes based on their goals. It should be noted that in the graduate education field—i.e., in the master's and doctoral programs—scientific research is carried out to generate knowledge, expressed through the defense of master's and doctoral theses, as well as the publication of scientific articles and books (Figure 2). These outputs must strictly comply with the guidelines of scientific methodology and communication.

Doctoral theses are expected to generate new knowledge, either basic or applied, of scientific significance and social impact. While they may address original or already existing problems, they should explore them extensively, capable of making a substantial impact within the scientific community. Because of the quality of the knowledge generated, they should serve as essential references for researchers, academics and governmental authorities [51].

Master's theses, under the same reasoning, should contribute new knowledge while demonstrating the research capacity acquired by the candidate in his/her discipline. They should be methodologically rigorous, explore novel and relevant topics of the specialty, delve deeply into discussion and offer conclusions applicable in practice. All of this will favor the advancement of knowledge in the research discipline.

Effective dissemination of this research is paramount, with institutional guidelines for publication in prestigious journals playing a crucial role. The number of articles and defended theses serve as indicators of the academic excellence of the graduate programs [52].

Academic works aim to enrich the professional competencies of future specialists in their respective fields. Unlike the doctoral and master's programs, these second-degree programs do not seek to train researchers or generate new knowledge; rather, they focus on nurturing critical thinking and research skills through academic works such as research projects, minor theses or monographs, clinical cases or original research. Thus, research output in a second-degree program is linked to FR (Figure 2).

On the other hand, minor theses—developed within the framework of the FR—should reflect a methodological commitment but without the required rigor or depth in the theoretical review, typically of lesser complexity compared to that of full theses [53].

Theses to earn the professional degree are academic documents that demonstrate undergraduate students' research skills. As such, they serve as formative exercises in themselves, which is why they are integrated into the FR. Although they may not always entail innovative research, those that do may be suitable for publication as scientific articles.

The publication of theses to earn the professional degree and of some academic works in indexed journals is recommended when they meet the criteria of methodological excellence. However, barely 4.5 % of undergraduate theses have been published [54]. A recent study concluded that barriers to publication included unfamiliarity of publication procedures and limited access to experienced research advisors [55,56]. Challenges in research quality often stem from deficiencies in student training and advisor experience [57-59]. Despite recent significant advances, they remain suboptimal [60,61].

The requirement for undergraduate students to conduct research for graduation and for professors to maintain their positions has led to the emergence of a number of unethical and potentially illegal behaviors. This situation has fostered the spread of a "publish or perish" culture, leading to unsatisfactory scientific practices such as questionable authorship, redundant publications, plagiarism and the proliferation of predatory journals [62].

ROLE OF PROFESSORS

Latin American universities categorize professors into two groups: research professors and teaching professors [3] (Figure 3).

1. **Research professors:** Individuals primarily dedicated to research and affiliated with research institutes. Current regulations limit their teaching hours, often assigning them only one course per academic year. This scheme operates on the premise that allocating more teaching hours would reduce the time available for research. In addition, the evaluation of their performance usually focuses on the quantity and quality of their publications. This group includes "clinical researchers," if they are engaged in both clinical research and practice; "clinical scientists," who are physicians conducting laboratory research; and "physician-scientists," who do not perform clinical practice and are only focused on research [63].

2. **Teaching professors:** Individuals responsible for professional training, working across basic sciences or clinical practice. While they also conduct research and publish, they achieve greater learning in their students, so they are required to conduct research to maintain their academic position [64].

   However, they face challenges due to limited time and resources available to conduct research, compared to research professors, because of educational

institutions' structural and organizational constraints. They often face a dual evaluation: through student surveys to assess their ability to teach and through publications to assess their contributions to research. "Clinical researchers" may belong to this group.

In the 21st century, teaching professors should demonstrate proficiency in several areas, including pedagogy, educational management and research. The latter encompasses:

a. **Undergraduate FR:** They should show skills in all forms of FR, such as applying research methodologies to review scientific literature, identifying research problems, and guiding students in the design, conduct and elaboration of research reports.

b. **Research advising:** They serve as mentors and committee members overseeing the design and development of research projects at both undergraduate and graduate levels, often culminating in theses or academic works.

c. **Own research:** They conduct research aligned with the school's or health care institution's research areas, thus contributing to the generation of new knowledge in their field.

Therefore, being a professor in a school of health sciences in the 21st century demands a set of skills and competencies in teaching, clinical practice and research. These skills and competencies are applied from undergraduate training, through advising on research projects, to conducting their own research. This role is pivotal in advancing and disseminating knowledge within their respective fields.

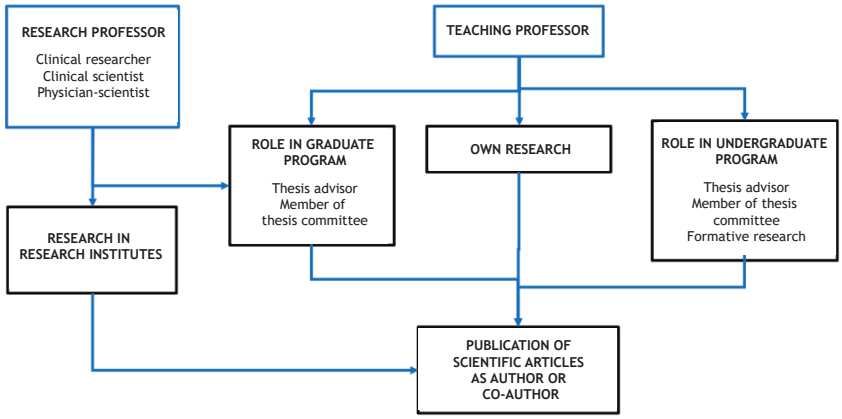

Figure 3. Role of university professors in research in schools of health sciences

CONCLUSIONS

Research in schools of health sciences is not only an essential activity but also an important and mandatory one. It plays a crucial role in preparing highly skilled professionals, capable of addressing the challenges in the field of health, and actively contributes to the generation and dissemination of knowledge for the welfare of society. Research institutes, along with graduate programs in the form of master's and doctoral degrees, play a fundamental role in fostering the generation of innovative knowledge.

RT, integrated with FR, plays a key role in shaping students' research skills. This training is effectively complemented by the participation of enthusiastic students in extracurricular activities, where their interest in research can be further nurtured. This whole process is carried out by professors with research skills, who play a fundamental role in guiding and supporting the growth of students in their future profession and as researchers, while also developing their own research.

Finally, solid university management establishes the necessary regulations to supervise and regulate each stage of this research process, expressed in scientific publications. In summary, research in the field of health sciences goes beyond being a simple component. It is an important element that shapes education, drives innovation and enriches society. Through research institutes, graduate programs, RT, FR, extracurricular activities and professor leadership, an environment where research is not only valued but also fully integrated into the educational experience is fostered.

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