RESEARCH ARTICLES

Systematic Review of University Research Hotbeds as a Training Intervention

Revisión sistemática sobre los semilleros de investigación universitarios como intervención formativa

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Summary

This review compiles the information related to implementing research hotbeds as formative research strategies regarding higher university education. A systematic review-type study was designed. Methodologically, the databases Scopus, Web of Science, SciELO, Redalyc, MEDLINE (PubMed), ERIC and academic Google were investigated, using the terms: "Research hotbeds", "programs", "research skills" and "undergraduate student". Of the 235 sources initially searched, 22 references were analyzed (17 original articles and 5 theses). The information was analyzed according to the categories of place of publication, objectives, methods and results found. Studies were found with the qualitative approach (68.2%), others the quantitative approach (27.3%) and others a mixed approach (4.5%). Implementing a seedbed has a positive influence on the enhancement of research capabilities, achieving greater motivation among seedlings and better learning related to research methodology. Several studies found that the interrelation between teachers and students that is achieved in a nursery facilitates the learning of research and highlights the role of the student's protagonist, representing a leader in their pedagogical development. It is concluded that a university research seedbed is a learning community whose purpose is to encourage the research culture and the training of competencies in its members; The interventions carried out with the seedbeds have evidenced an improvement in research skills and an increase in student scientific production.

Keywords: Higher education; Investigative competence; Research training; Scientific investigation.

Resumen

En la presente revisión se recopila la información relacionada a implementar semilleros de investigación como estrategias de investigaciones formativas respecto a la educación superior universitaria. Se diseñó un estudio del tipo revisión sistemática. Metodológicamente se indagaron en las bases de datos Scopus, Web of Science, SciELO, Redalyc, MEDLINE (vía PubMed), ERIC y el buscador Google Académico, usando los términos: "Semilleros de investigación", "programas", "competencias investigativas" y "estudiante del pregrado". De las 235 fuentes inicialmente buscadas se analizaron 22 referencias (17 artículos originales y 5 tesis). La información fue analizada según las categorías de: lugar de la publicación, objetivos, métodos y resultados encontrados. Se encontraron estudios con el enfoque cualitativo (68,2%), otros el enfoque cuantitativo (27,3%) y otros un enfoque mixto (4,5%). Implementar un semillero influye positivamente en el acrecentamiento de capacidades en la investigación, logrando una mayor motivación entre los semilleristas y mejores aprendizajes relacionados a metodología de la investigación. Diversos estudios encontraron que la interrelación entre docentes y estudiantes que se logra en un semillero facilita el aprendizaje de la investigación y resalta el rol de protagonista del estudiante, representando un líder en su desarrollo pedagógico. Se concluye que un semillero de investigación universitario es una comunidad de aprendizaje cuya finalidad es incentivar la cultura investigativa y la formación de competencias en sus integrantes; las intervenciones realizadas con los semilleros han evidenciado una mejora en las competencias investigativas y un aumento en la producción científica estudiantil.

Palabras clave: Educación superior; Competencia investigativa; Entrenamiento en investigación; Investigación científica.

Introduction

The teaching-learning and evaluation process in the university context must go beyond professional training and involve its members in the construction of knowledge and problem solving that involves a community through science, technology and innovation. This model can be achieved when research and the development of competencies that help solve problems of current reality, and interpret the context from scientific theories are encouraged (Gómez et al., 2016). In this regard, university is called to be the institution that develops research skills in students, as well as to develop scientific research for the solution of problems in a society.

Knowledge society (KS) makes the university require transformation processes: institutional policies, changes in curricula, new pedagogical models, improvement of scenarios and training of educational agents (Chauca & Ragas, 2021). In Knowledge Society, the quality of research in higher education (HE) is associated with research practice in two ways: teaching research and doing research (Rodríguez, 2016). Doing research and teaching research have different logics. Although both complement each other, they are focused on different learning processes. Teaching research is a complex and diversified process. As Sánchez (2014) indicates, "research is not taught with chalk and slate but through practice. It is taught as if there were a unique and repeatable procedure: first accessing scientific knowledge, training in it and then defining its disciplinary field. There is no single method. In practice, students must recognize their area of interest in their research field." (p.31) Teaching research includes an analytical program that includes thematic units, and then encountering significant experiences in research.

However, in the university context, there are some characteristics that limit the development of competencies such as: research attitude is limited to teaching courses related to the methodology for scientific research (MSR), creation of rote learning environments, where cooperation and exchange do not predominate, there is little development for observation, experimentation, critical analysis, innovation (intellectual operations typical of research). Research training is intended to be limited to MSR courses (it is usually decontextualized from specific topics) and thesis projects where teachers' work is usually spontaneous (Rodríguez-Vargas et al., 2020). Research training of the student is limited to theoretical courses, decoupling it from research praxis or the reality of a society. In most university programs, research training (RT) is based on the critical socio-humanistic paradigm that involves studying and relying on the training process as a teaching method. However, this limits the creative and critical process of student training, so it is necessary to link the epistemological, theoretical and teaching-learning strategies (Muñoz et al., 2015). Another problem in the context of university education is the weak relationship between research and teaching, which limits the importance of social development linked to scientific progress (Quezada et al., 2020). This occurs because most teachers do not include or consider research as one of their functions, either because they are unaware of it or because they lack time to fulfill it (Ríos-León, 2014).

Despite the problems faced by research training and the development of research skills in the university environment, some pedagogical strategies have been developed that promote formative research and the development of a research culture from undergraduate studies that are presented as epistemological trends within the research pedagogy. These strategies include "scientific summer" programs (Magaña et al., 2014); "problem-based learning" (Herrera, 2013); "research assistants"; "research assistants" and "research hotbeds (RH)".

Research Hotbeds arise to encourage motivation, participation and continuous learning in the practice and methodology of scientific research; participating students (research incubator students) discuss in research practices. This practice allows them to develop basic research skills. Quintero et al. (2008) add that, "Research Hotbeds appear as a space where the student is involved with the researcher's work, who acts as a tutor, creates a learning community around a topic to

be studied, creates projects, develops them, socializes and seeks resources to support themselves" (p. 35). García (2009) defines them as a community that presents an interest in knowledge, equity and situations that happen every day. Restrepo (2003) mentions that "the Research Hotbed acts as a capital for training in research, formation of learning and research communities, through the deconstruction and reconstruction of research methods, through the contextualization of problems and participation in networks." (p. 8) These Research Hotbeds are more frequent in the Latin American context, mainly in Colombia, Chile, Peru, Venezuela and Ecuador (Molineros, 2009). This is why the main sources of information come from these countries.

Research Hotbeds allows RT to transcend in the university by linking theory with practice. Here a critical approach is crucial to link the work, academic and research aspects in a dialectical way and to propose innovation measures in order to appropriate procedures, methods and techniques related to the development of scientific knowledge, which justify the social relationship and explain the cognitive character required in the teaching performance (Urrego et al., 2014). In this regard, in a Research Hotbed, research has a formative character that is of approaching, initiation, awakening the "investigative spirit" and "motivation" towards research (Martinez-Daza et al., 2021).

Research Hotbed emerges as a space for comprehensive training that aspires to remedy or complement the university curriculum (Ossa & Sierra, 2001), as a response to a non-conformity of the educational system that privileges the extrinsic motivation (grades) and not the intrinsic one, that is, the dedication to study as a result of one's own commitment, responsibility and enthusiasm for learning. Although Research Hotbeds are not current in the Latin American and global context, their effects as interventions have been little studied and there are studies on how to implement them, how to manage them and what are their foundations. Hence, it is necessary to compile the studies that have implemented Research Hotbeds as an intervention and systematize its short- and long-term effects. The contribution of this study lies in describing the studies that can be replicated in the different faculties of the university system. Summarizing the findings of Research Hotbeds would make it possible to assess how to implement and evaluate them in students.

Research Hotbeds are included in some university policies mainly in the Latin American context, and the term "research hotbed" is uncommon in other contexts where other terms are used such as research groups and research experiences. Because it is mainly a pedagogical strategy of formative research, it is linked to the teaching-learning process of research skills (RS), so it deserves a deeper understanding of its characteristics, development logics, theoretical foundations, characteristics and meanings. The impact of Research Hotbeds has been little studied from an ethnographic approach, as a case study and through the scientific production carried out by the students who participate in the activities of the research hotbed. Little is known about the effect Research Hotbeds have on the student's perspectives and education from their learning process. Hence, there is a gap related to the information that summarizes the findings that have been found by the studies that implemented a Research Hotbed in higher education.

In this regard, the purpose of this article is to review in a systematized way the results of the implementation of the research hotbeds in different university programs. The justification lies in the need to systematize information related to Research Hotbeds as an educational intervention that allows authorities to make decisions for their implementation in the undergraduate system.

Method

A literature review study was designed and it is a technique for identifying, evaluating and synthesizing the scientific, academic or practical knowledge of a field of study. Its objective is to

systematically explore what has been done or published on a topic (Randolph, 2009). For Grant and Booth (2009) and Booth, Papaioannou and Sutton (2012), the systematic review focuses on the analysis and exploration of areas of knowledge and areas of research. Its function is the identification of the main trends and currents in an area, as well as the detection of gaps and research opportunities. They summarize the review as a study aimed at a variety of objectives, with one of the main ones being the elaboration of the literature review in any field of the human and social sciences.

The purpose of the review was to study the original (empirical) articles that implemented a research hotbed in the context of university education. The articles were searched in the databases Scopus, Web of Science, SciELO, Redalyc, MEDLINE (via PubMed), ERIC and the Google Academic search engine. The sources were searched in the period 2010-2020 with the intention of obtaining the most up-to-date articles.

The search terms were obtained from the thesauri: Institute of Education Sciences (ERIC), Medical Subject Headings (MeSH) and Descriptors in Health Sciences (DeCS). From these search engines, the following terms were obtained: "program", "research skills", "undergraduate", "research skills" and "undergraduate students". The term "research hotbed" was not found in any thesaurus, however, it was included for the search for information. Thus, the search algorithm was: ("Research Hotbed" AND "research competence" AND "students"), ("Research Hotbed AND " university students"), ("Research Hotbed" AND "programs"). The English terms for the search included: "research hotbed", "hotbeds of research", "student research hotbed" and "student research hotbeds". Once the articles were found, the search was complemented with bibliographic references to detect information that was not identified from the databases.

The criteria for selecting the sources of information included original articles or theses published in Spanish or English, articles that had as an intervention "research hotbed" and presented results of the intervention, articles published in the last 10 years and articles referring to university programs. Reviews, letters, notes, books, reports, interviews that did not have the structure of an original (empirical) article were excluded.

In a first stage, all the sources that had the term "research hotbed" in the title of the source were included. Subsequently, the sources by year of publication, repeated publications or those that indicated in the title that they were not original sources were filtered. In a second stage, the abstracts were analyzed to detect whether or not they complied with the structure of a structured abstract, as well as to identify whether they presented research hotbed as an intervention and the results. This work was carried out by two researchers, who independently analyzed the abstracts. After detecting the potential abstracts, the sources of information were completely read. At this stage, it was identified whether the sources presented findings after implementing a research hotbed, and whether this source was related to university programs (Figure 1).

The articles were downloaded in their PDF format and the information was collected in Excel, using the categories of authors, country of publication, name of the journal, title of the source, type of source, objective of the study, methods used, population/sample/place of execution, main results, comments and conclusions.
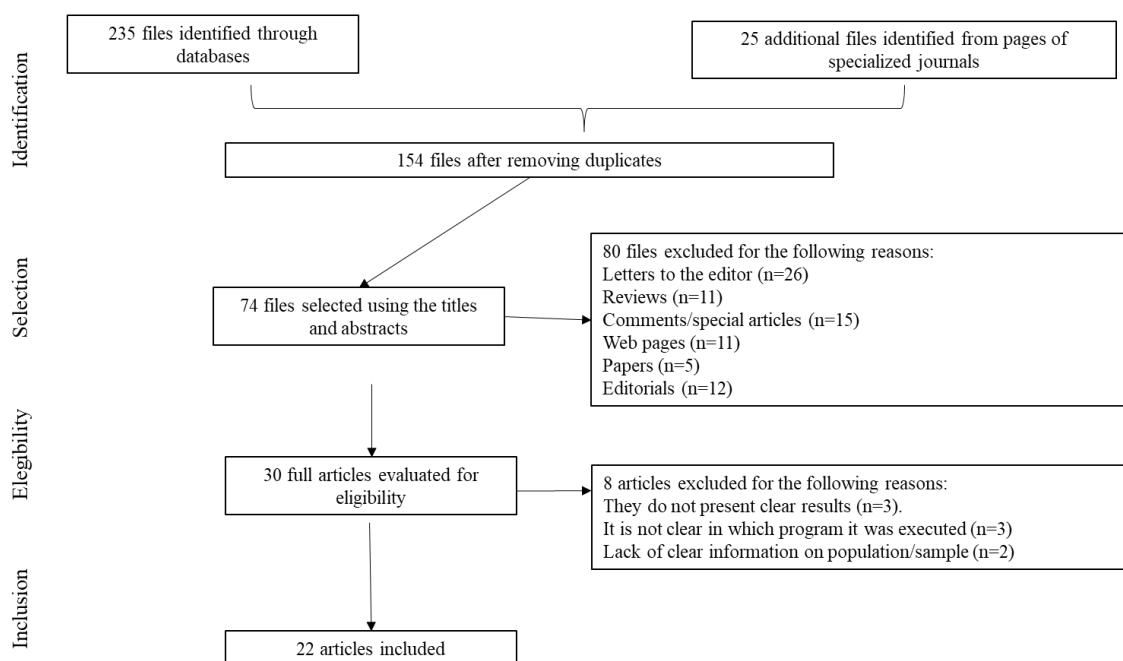
Figure 1.
Process of identification and selection of items according to PRISMA

Results

We found 22 articles that developed a research hotbed and assessed the results of the intervention. 77.3% (n= 17) were original articles, while 22.7% (n=5) were theses. The countries of origin of most sources were Colombia (72.7%) and Peru (13.6%). The programs where they were implemented included faculties of Administration, Psychology, Education, Electromechanical Engineering, Dentistry, Economic Sciences, Nursing, Physics, Statistics and Social Work.

Of the articles found, some of them followed the qualitative approach (68.2%), others the quantitative approach (27.3%) and others a mixed approach (4.5%). Of the quantitative studies, most of them implemented research face-to-face hotbeds. Therefore, the study conducted by Gómez and Jimenez (2015) found greater motivation among research incubator students and better learning related to methodology, statistics and sampling. The study conducted by Granadillo and Gallardo (2016) notes that "the role of teaching advisors of a research hotbed must involve the use of strategies that keep motivation of research incubator students, including teamwork, formulation of problems and generating areas of research and debate of difficulties worldwide." (p.4) The study conducted by Alvites-Huamaní (2015) indicate that a remote research hotbed can be implemented through the use of information and communication technologies while creating research, meditation and training environments for research education (Table 1).

From the studies with a qualitative approach, Bolívar (2013) notes that "a RH is a space to develop that capacity, skill, there is a learning of method and technique where the recent researcher will use." (p. 436) Caamaño, Rebolledo & Tutor (2018) found that the practices of a RH allow students to publish scientific articles, while Cantú, Medina & Martínez (2019) add that "the interrelationship between teachers and students that is achieved in a research hotbed facilitates the learning of research." Most studies with a qualitative approach followed a "case study" design, while some followed a phenomenological design. López-Ríos et al (2016) in an

ethnographic design, indicate that research hotbeds highlight the leading roles of students as leaders of pedagogical development (Table 1).

A study that used both approaches (epistemological complementarity) in which Suárez, Ceballos and Obispo (2013) indicate that "a research hotbed allows students to acquire research, emotional and social capacity, training them to face the labor future with more capacity" was found. (p. 382) At the same time, they have the accessibility to obtain ability and skills with respect to research from the beginning of the profession and intervene in educational groups, allowing them to generate reflection and discussion of transcendent aspects related to health, the nearby environment and life itself (Table 1).

Table 1.
Findings from studies that implemented a research hotbed in the university context

Authors	Purpose	Methods	Place	Results
Alvites-Huamaní (2015)	To strengthen research, producing and developing remote research hotbeds.	Intervention study implemented by a research hotbed.	Peru. Universidad Alas Peruanas School of Human Psychology. 15 students between 22 and 35 years old.	The production and development of remote educational research hotbeds generates benefits, because it contains a series of components and computer tools such as chat rooms, conference rooms, emails, etc.; which are usually used naturally by students. The research hotbed makes it possible to create areas for research, reflection on and instruction in research.
Bolívar (2013)	To study the relationship between research in the strict sense and formative research through a research hotbed.	Qualitative, descriptive, and explanatory study, focused on the case study.	Colombia. Universidad de Antioquia.	Research hotbeds are environments where capacities, skills are produced, procedures and techniques that the recent researcher will use in the future are studied. They are carried out in environments where voluntary lectures or subjects are taught to students and teachers who want to be researchers in the future.
Ca. et al. (2018)	To analyze the structure, main theme of the research hotbed, mission and objective.	Descriptive study from the case study approach.	Colombia. Universidad del Atlántico. Physics Program.	In research hotbeds, research and training activities are carried out: preparation of projects related to modeling, synthesis and characterization of magnetic nanoparticles. The research hotbed dissemination work has been considered essential during each weekly meeting planned by the leader, in academic activities and product standardization: organization of courses, participation in seminars, organization of workshops, etc.
Cantú et al. (2019)	To propose administrative, academic mechanism and element methodological that promotes the development of the researcher.	Qualitative study of participatory action-research where a research hotbed was implemented.	Mexico. José Mario Instituto Tecnológico Molina Pasquel y Henríquez. Electromechanical Engineering Program. 19 students.	A research hotbed seeks to contribute to the comprehensive training of current and future professionals through the research knowledge approach as a strategy to develop thinking and solve problems. It seeks to respond to the need to fit students and young professionals, already mentioned, in the praxis and scientific research methodology.

Gómez & Jimenez (2015)	To characterize and understand aspects of interest about the experiences of research hotbeds	Descriptive exploratory study.	Colombia. Universidad Pedagógica y Tecnológica de Colombia, Tunja Statistical Program.	The research hotbed generated greater motivation for learning about sample designs, a topic that according to sampling theory presents high levels of difficulty in students. This motivation was reflected, among other aspects, in the formulation and development of degree project proposals on these topics.
Granadillo & Gallardo (2016)	To establish training practices introduced into the process Involved in the process of research skills in each research hotbed.	Non-experimental, descriptive study.	Colombia. Universidad Francisco de Paula Santander Ocaña. 13 teacher tutors	Stimuli to encourage research hotbed students are based on working groups and adequate metrics in teaching and obtaining research skills, but depending mostly on how each teacher uses the strategies and the fact that the student does not waste initiatives and dedication. 69.24% offer students the creation of essays.
López-Ríos et al. (2016)	To analyze the experiences, stories, cultures, some difficulty and challenges of research hotbeds in public health and epidemiology	Qualitative and ethnographic study.	Colombia. Universidad de Antioquia. Three research hotbeds. Nursing and Health Administration Programs. 30 Students	The research hotbed represents a free environment for students with a free mind, whose purpose is to generate leaders in research with an academic degree, social obligation and to provide humanitarian quality. It enables integral teaching and learning; adequate reflection and criticism; distribution; work of originality and of being.
Suárez et al. (2013)	To explore the imaginaries that research incubator students have, about the development project during undergraduate studies.	Study with an approach of epistemological complementarity (qualitative and quantitative)	Colombia. Universidad del Magdalena. Faculties of Education. 72 students.	The research hotbed project allows students to achieve research skills, as well as emotional and social skills, organizing them to face the professional future with increased competence. It presents the options to obtain research skills and abilities and the participation in the educational association that provides reflection and discussion about important aspects associated with health, close environment and life itself.
Vega-Monsalve (2019)	To understand the techniques that provided the configuration and stabilization with respect to the research hotbeds.	Qualitative study, with hermeneutic approaches and case study methods.	Colombia. Higher Education Institution Occupational health administration program. 16 students	Stimulus, functioning of the work, execution of the teacher, who is leader and supporter of the institution. Although the groups created are research development strategies, they need adequate care with respect to exercises and quality in the human relationship that the work addresses.
Merlano et al. (2017)	To identify and analyze students' perspective and consideration on research seedlings	Quantitative study using the survey for data collection	Colombia. Universidad Simón Bolívar. 18 students from the Business Administration project.	It was concluded that most of the students show interest in belonging to a research hotbed because it will be of great help to them in their graduate education. However, very few participate in this type of educational strategy as they consider it to be a very demanding activity.

Mujica (2012)	To propose project-based learning as a strategy for strengthening and better organizing the research hotbed	Case study, designed to work on the On-site modality	Universidad Autónoma de Bucaramanga	Students found in this strategy a more practical way to conduct research where they enhance the development of skills that are useful in their professional life. They also learn to work as a team and responsibility are given to each of the members who are required to fulfill the roles within a set time.
Flores et al. (2019)	To document what has been produced on research hotbeds in Latin America.	Documentary and descriptive study	50 sources analyzed from Colombia, Peru, Mexico, Ecuador and Venezuela.	The country with the largest number of articles found on research hotbed was Colombia with a total of 22 articles, followed by Mexico (15), Ecuador (06), Venezuela (4) and finally, Peru (03). It is concluded that the implementation of research hotbeds contributes to the scientific production of these countries, by increasing the publication of scientific articles in journals of high impact and international recognition.
Andrade-Salazar et al. (2018)	To understand social representations about dropout, permanence and commitment to research hotbeds	Qualitative research through semi-structured interviews	Colombia. Universidad de Buenaventura 30 students: 10 who did not enter the research hotbeds, 10 who remain there and 10 who dropped out.	The main attitudes leading to dropout are lack of interest, lack of time and lack of motivation to conduct research. The relationship with the mentors/coordinators of the research hotbeds also has an influence, so good leadership is of vital importance for the permanence of the students.
Díaz-López et al. (2019)	To identify factors that influence the low incorporation of students in research hotbeds.	Quantitative, descriptive and explanatory study with collection of primary information, by means of 1 survey.	Peru. Universidad Nacional de la Amazonía. Business Administration program, 205 students	The majority of respondents (91.2%) are interested in belonging to a research hotbed, but there is a notorious lack of commitment to assume the obligations and effort that this type of extracurricular activity requires. There is also lack of time and space. Almost all students (98%) consider that belonging to a research hotbed enriches their resume and makes them more competent in their work area.
Naranjo A, et al. (2020).	To describe the research process of students belonging to a research hotbed	Qualitative descriptive study through interviews and documentary analysis.	Ecuador Universidad Politécnica Salesiana. Systems Engineering and Computer Science Program	It is concluded that belonging to a research hotbed develops in the student skills and competencies that will allow the growth of a competent professional in society and a future researcher.
Gomez et al. (2019)	To recognize the lessons learned and the challenges faced by the research hotbeds Universidad Militar Nueva Granada	Exploratory research with qualitative approaches from a case study.	Colombia. Universidad Militar Nueva Granada Economic Sciences Program	The research hotbed is recognized as an extracurricular activity that trains researchers. It accompanies educational development and enhances the essential skills to carry out research, so that professionals are trained to perform in an effective manner. Students are interested in

				belonging to a research hotbed not only because of their choice of degree, but also to develop skills that are complementary to the development of formal learning, and the job projections they obtain.
Durán & Peña (2014)	To promote research development techniques to strengthen learning projects and research hotbeds	Study with a qualitative approach of a descriptive type	Colombia. Corporación Universitaria Minuto de Dios (UNIMINUTO). Financial Administration Program.	Based on the results, it is concluded that research hotbeds are the ideal strategy to educate students in research, allowing them to obtain more knowledge and thus having a broader curriculum. For this reason, *UNIMINUTO Virtual y a Distancia* decided to conduct the formation of research hotbeds in a virtual way, in spite of traditional future projects, which will be carried out through technological platforms that have the Headquarters, creating virtual spaces for each research hotbed and instruments such as forum, chat, blog, etc.

Theses found evaluated the impact of a research hotbed. Rodríguez's quasi-experimental study (2016) specifies that implementing a Research Hotbed has a beneficial result during the process of research skills. Gallardo (2014) says that "research incubator students respond to institutions and their work in research, having assignments with direct participation in the development of cognitive production." (p.132) (Table 2)

Table 2.
Findings of the theses that implemented a research hotbed in the university context

Authors	Purpose	Methods	Place	Results
Carrillo et al. (2018)	To identify the process of shaping and consolidating a research hotbed.	Hermeneutical qualitative study of the systematization of experiences.	Colombia. Fundación universitaria católica Lumen Gentium. Social work program.	Living the experience in the research hotbed contributed to the research training of students, but also to social training because it meant learning about tools and/or elements, strategies and methodologies of social research that would allow students to formulate research projects, such as degree project.
Gallardo (2014)	To cover the meaning and perspective of each research hotbed.	Qualitative study of hermeneutic and phenomenological type	Colombia and Chile. 267 students.	In each research hotbed, we find concentrations of reconfigured classes of young people with required collective opposing activities. Young people respond to institutions and work in research, as long as it deals with assignments of direct participation in the development of cognitive production.

Rodríguez (2016)	To demonstrate the effects of a "hotbed for researchers", within the process of research skills.	Quantitative study with quasi-experimental design	Peru. Universidad Nacional Mayor de San Marcos Faculty of Dentistry 18 students	The educational strategy "research hotbed for researchers" generated positive results during the process of research skills because there were statistical inequalities between the control group and the experimental group. After the evaluation of the projects, significant discrepancies were obtained between each group, 22.5% for the control group considered as competent and 50% for the experimental group.
Rincón (2018)	To improve the social interaction of a research hotbed	Qualitative approach and an educational action research design	Corporación Universitaria Minuto de Dios. Psychology Program	Innovation helps to socialize with other research hotbeds and teachers, improving the spaces for research hotbeds for the strengthening of formative research, thus promoting the development of research skills and competencies.
Soto & Ruiz (2019)	To systematize the pedagogical experience of a research hotbed	Qualitative experience systematization study	Colombia. Universidad Tecnológica de Pereira Communication and Educational Computing Program	The systematization carried out allowed the students of the research hotbed to chronologically classify and organize experiences about the usefulness of ICT of the teachers interviewed.

Discussion

HRs are created as part of the institutional mission to strengthen the research system, promote formative research and research in students; stimulate the question in university daily life, strengthen the academic-research relationship and multidisciplinary interaction; generate a research culture by bringing the student closer to research, and generate mechanisms to link students to research groups (Garza et al., 2021). As part of university education, research development allows students to become familiar with the processes of searching for and analyzing information, and even allows them to gain experience, so that they can later pursue a graduate degree or dedicate themselves to scientific life (Van Wijk et al., 2018). This is because a student and a professional are required to be updated with the advances in their fields of specialization, and therefore, it is essential that they know how to critically evaluate the sources of information. Implementing a Research Hotbed in a university program is considered as a strategy that provides research skills (RS). In this regard, this strategy has been implemented in different Latin American universities, obtaining different results. This study compiled the interventions that have been carried out with Research Hotbeds in different university programs.

From the studies found, many of them agree that the objective of Research Hotbeds is to create a space where the development of research skills can be promoted from undergraduate studies. It also seeks to promote research culture through the development of research projects and participation in academic events, all of which also implies professional development. The projects and activities of the research hotbed can focus on the creation or recreation of knowledge. It is not necessary that this knowledge be scientific, since the intention is that the student becomes familiar with research processes (González & Medina, 2022). The vast majority of sources found were implemented in Colombian universities, as this is the country with the longest tradition of

research hotbeds and with a greater organizational structure. Research Hotbeds according to Molineros (2009) began in 1996 at the Universidad de Antioquia; in Chile they aroused in 2000 (Gallardo, 2014) and there are antecedents in Peru, Ecuador, Chile, Mexico, Colombia and Venezuela. These strategies resemble course-based research experiences where classes and sessions can be combined with research activities to provide ongoing training in key research skills (Esparza et al., 2020). According to Auchincloss et al. (2014) what is sought is for students to: (1) engage in scientific practices, including the development of technical skills and the use of the scientific method, (2) discover new experiences because the result of an experiment is not known to the students or the teacher from the beginning, (3) ask research questions that have relevance and meaning beyond the classroom setting, (4) collaborate with their peers, upper-year students, teachers and researchers and (5) practice (repeat) as the experiments are repeated, refined and examined, generate more objective results and concrete knowledge.

Research Hotbed reinforces the university's strategic function of a university to train students in research. They are configured as groups with specific practices (Jojoa, 2021). According to the studies found, a research hotbed presents organized practices where beliefs and subjectivities are built and confirmed by the subjects themselves. A conviction that the group must continue through a sense of relevance, of being reciprocal with their peers 'learning is achieved. They build a code of reciprocity based on the belief that they can learn more than what the university gives them, they believe more in their abilities and that the practices they develop each week will serve them for their professional training. This model helps to move away from traditional university education by allowing the student to be an active agent in their learning. (Flores et al., 2022). This is in line with what some educators have argued that for students to value the skill-building process, they should not be immersed in traditional higher education where classrooms are teacher-centered and students learn isolated from each other, rather than through collaboration with each other in a shared learning process (Astin, 1985; Barr & Tagg, 1995).

A research hotbed breaks with this tradition and allows students to have autonomy and independence to decide their training process of research competencies. The practices of a Research Hotbed are structuring spaces where formative research strategies are developed and research skills are promoted (Ojeda-Pérez, 2021). This restructuring within a research hotbed allows students to participate more actively in a sustained academic relationship with other students and faculty over a longer period of time than in the traditional setting of a course. These models of "restructuring" and "self-management" are raised by Leigh and Rosetta (1988) when they indicate that, "this restructuring supports effective learning and creates a greater sense of academic community between students and teachers," (p. 39) This allows the increase of the amount of time between students and faculty members, in addition to the fact that the teachers who accompany the student group are much more aware of learning style and needs of each student; likewise the students are much more aware of each other and of their peers' learning.

Various epistemological approaches founded have been used to analyze the impact and results of Research Hotbeds when they have been applied in higher education. Descriptive, ethnographic, evaluative, phenomenological, interpretative studies are included, etc. The main findings indicate that research hotbeds have been applied as educational interventions in order to improve research skills, increase the scientific production of teachers and students, promote a research culture, develop formative research, value learning and student satisfaction. As experiences in research are intended to help students integrate the complex stages of conducting authentic research (Brownell et al., 2015), their scientific identity, self-confidence, content knowledge, and scientific literacy are fostered (Olimpo et al., 2016). Also, there are gains associated with participation in research internships, improvements in their scientific self-efficacy, research skills, improved academic performance, and intention to persist in a scientific discipline in graduate school (Rodenbusch et al., 2016).

We highlight the ethnographic study conducted by Martínez, Calderón, Castillo and Nava (2016). This study found that a Research Hotbed helped to structure the formation of research-related competencies that will set the parameters for other processes. The research hotbed made it possible to consolidate theoretical topics and bring research practice closer to professional practice. A greater relevance was also achieved in determining the object of study (from its professional practice), data collection techniques, discussion based on dialectical confrontation (previous thesis and proposed theory), publication of articles. Moreover, values such as respect and tolerance are conceived of as meaningful. Meaning and significance is given to values such as respect and tolerance. Professional ethics and knowledge opportunities are better understood. Interaction with other members facilitates coexistence and professional integrity. This teamwork will materialize in interdisciplinary works in the future. The diversity of students participating in a research hotbed (not only involving students from the same class year) also favors learning because it allows the use of multiple strategies, encourages upper- year students to become teachers, encourages lower-year students to establish relationships with graduates, teachers and advisors, takes advantage of the multiple experiences of those who already know the university system and those who are just starting out in it.

The impact of a research hotbed is analyzed from the research competencies achieved in their students. These competencies should be assessed through the critical attitude towards scientific evidence, the ability to implement methods to solve problems, the ability to write essays and scientific articles, and the ability to present findings either through presentations or reports (Martínez et al., 2016). Although there are studies that have studied Research Hotbeds from different methodological approaches, they can be better understood through qualitative studies, whether case studies or ethnographies, as a methodological option that recreates the experiences within the research hotbed, its social and cultural reality. In addition, multiple studies following these approaches are incorporated. These methods allow us to analyze the experiences and critical experiences of each student within their context, their dynamics, meanings and research perception (López-Ríos et al., 2016).

Based on the interventions analyzed, it was found that Research Hotbed can be located between Formative Research and Research Training (RT). It is a path that includes various strategies to develop rigorous logic, human advantage and analytical skill. Students enter and stay because of curiosity, interest, finding the possibility of exchange and discussion, as well as looking for a different learning space (Hernández, 2012). For the Research Hotbed to fulfill its objectives, agreements, personalities, physical environment, roles, internal and external dynamics are required (Guerrero et al., 2019; Molina, 2002). Several authors agree that the Research Hotbed is a learning space, seeing them as learning communities identifies their function within a university context that is interested in the nature of research and research processes within that community. In this community, students acquire a constructivist training where they practice research and constantly acquire new experiences that question those learned and modify their understanding (Schwandt, 2000).

The Research Hotbed is a phenomenon that occurs in the university, social context, community and national systems in science and technology. Research incubator students are the main actors so studying the Research Hotbed implies giving the subject a voice. From a logic of theoretical construction, it is explored around the subject (Stenhouse, 2016). They are based on autonomous learning, dynamism and alternative spaces of disciplinary or interdisciplinary knowledge. They seek to make the learner acquire knowledge and become restless in the search for questions and solutions. While students exposed to early research experiences report significant gains in their research self-efficacy, when these data are analyzed over the long term, no significant differences are found compared to students who did not have such experiences. In fact, a decrease in scientific identity from baseline to the end of the second year of studies is reported (Ott et al., 2020). While it is not entirely clear what could be causing this decline in scientific identity, the self-efficacy of research may be improved, without affecting the scientific

identity of students. It may also be due to a student demotivation "sophomore slump," in which students struggle or feel dissatisfied with the academic environment during their second year of their undergraduate experience (Webb & Cotton, 2019). There were similar findings in the study conducted by Wolkow, Jenkins, Durrenberger, Swanson-Hoyle, and Hines (2019), which indicated that students who participated in early research experiences perceived a greater understanding of what researchers do and a greater interest in pursuing a research career. However, by the final year of study, these positive perceptions had fallen to levels shared by those who did not take the experience. It is also indicated that multiple research experiences throughout a program are required to maintain learning gains.

The findings of this study allow us to conclude that a university research hotbed is a learning community, whose purpose is to encourage the research culture and the formation of competencies among its members. The interventions analyzed agree that Research Hotbed improves research competencies and scientific production, facilitates the identification of research problems and allows the student to approach their future line of research in a graduate program.

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