MENDIVE
REVISTA DE EDUCACIÓN

Review article

The formation of investigative scientific thought in Higher Education: theoretical-trend study

La formación del pensamiento científico investigativo en la Educación Superior: estudio teórico-tendencial

A formação do pensamento científico investigativo no Ensino Superior: estudo teórico-tendência

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ABSTRACT
The processes of formation of investigative scientific thought from universities and their evaluation have gained crucial importance. The objective of this study is to present a summary of the state of the art on this topic from the review of articles in scientific journals. For this, bibliographic analysis and documentary review were used as essential methods. The main result was a definition contextualized to the particularities of the countries of the region that allows a more objective evaluation of the phenomenon in Central America and the Caribbean. It was possible to conclude that it is essential to build a system of own, flexible and contextualized indicators that offers objective information on this process and allows decision-makers of Higher Education institutions to undertake improvement actions based on sharing good practices.

Keywords: Higher Education; scientific thought; university professors; university students.

RESUMEN
Los procesos de formación del pensamiento científico investigativo desde las universidades y su evaluación han cobrado una importancia crucial. El presente artículo tuvo como objetivo socializar el estado del arte acerca de esta temática, a partir de la revisión de artículos en revistas científicas. Para ello se empleó el análisis bibliográfico y la revisión documental como métodos esenciales. Se obtuvo como resultado principal una definición contextualizada de las particularidades de los países de la región, lo que posibilitó una evaluación más objetiva del fenómeno en América Central y el Caribe. Se pudo concluir que es indispensable la construcción de un sistema de indicadores propio, flexible y contextualizado que ofrezca información objetiva sobre dicho proceso y permita a los decisores de las instituciones de Educación Superior emprender acciones de mejora a partir de compartir las buenas prácticas.

Palabras clave: Educación Superior; pensamiento científico; docentes universitarios; estudiantes universitarios.

RESUMO
Os processos de formação do pensamento científico investigativo das universidades e sua avaliação ganharam importância crucial. O objetivo deste estudo é apresentar um resumo do estado da arte sobre este tema a partir da revisão de artigos em revistas científicas. Para isso, a análise bibliográfica e a revisão documental foram utilizadas como métodos essenciais. O principal resultado foi uma definição contextualizada às particularidades dos países da região que permite uma avaliação mais objetiva do fenômeno na América Central e no Caribe. Foi possível concluir que é essencial construir um sistema de indicadores próprio, flexível e contextualizado que ofereça informação objetiva sobre este processo e permita aos decisores das instituições de Ensino Superior empreender ações de melhoria com base na partilha de boas práticas.

Palavras-chave: Ensino Superior; pensamento científico; professores universitários; estudantes universitários.

INTRODUCTION

In today's world, the successful solution of the problems of daily life requires an algorithmization of thought, which makes it possible to face them from appropriate positions, because although not all of them require the application of science in their solution, the logical steps that it provides they facilitate the understanding and discernment of the type of actions that should be used. Hence the importance attributed to the formation of scientific thought in institutionalized education and, especially, in the university.

To achieve this, it is necessary to start from a detailed review of the state of the art on the formation of scientific investigative thought and build a system of indicators of its own, which takes into account the contextual characteristics of Central America and the Caribbean.

Education systems around the world have taken actions to promote the formation of scientific-investigative thought in the cloisters, so that they generate an innovative teaching-learning process that develops it in the students. However, this process is seen to be slow in most Latin American countries (Rivera, 2016), so studies of the phenomenon in the university context may be essential to transform this reality, by providing decision-makers with critical information that It allows them to draw up appropriate strategies. If, in addition, comparative studies are carried out between universities from different countries, new experiences on the subject can be learned.

Throughout the history of humanity, universities have served as the cradle of the most advanced knowledge, and discoveries of all branches of knowledge have been gestated in them. Over time, these centers gave priority to the development of science and technology, hand in hand with the emergence of new teaching-learning methods based on self-management of knowledge, creativity and innovation.

Currently, the value of a university is calculated based on the scientific achievements of its faculty and students, expressed in publications, invention patents and awards. Hence, the investigation of the behavior of these parameters and their stimulation through actions for the formation of scientific-investigative thought are essential. However, in our geographical area there are no studies of this type, except those carried out by international organizations, which generally use evaluation ranges typical of other contexts.

In summary, although the importance of the development of science and research from the university seems to be sufficiently proven, it would be necessary to describe clear methods to achieve it. Therefore, this article aims to socialize the state of the art on this subject, based on the review of articles in scientific journals.

DEVELOPMENT

The knowledge and use of science and technology to face the continuous problems that threaten the inhabitants of the planet, far from being easier, are becoming more and more complex, because the division into power blocks and the military, economic and social crises they are built into walls that isolate and segregate them.

In this scenario, the university training of a scientific-investigative thought becomes an urgent need, the only guarantee of the development of a country, because only if the new generations update their knowledge, diagnose the scope of the problems with scientific research methods, propose solutions based on new knowledge of science and technology, innovate and contextualize the contributions that other authors have made, and creatively and flexibly apply the findings in their social environment, it will be possible to face the increasingly complex challenges that are present; the COVID-19 pandemic is an example of this.

Hence, the object of study of this research focuses on the development of scientific-investigative thinking in teachers and students of Higher Education.

The project is conceived from the study of the main indicators of the Ibero-American region in science and technology; a compilation published annually by RICYT (Red de Indicadores de Ciencia y Tecnología), an instance belonging to the OEI, with the title *State of Science,* which shows in 2021 a decrease in spending in the Higher Education sector in Science and Innovation, as well as a decrease in key indicators such as the number of researchers per nation and the distribution of investment in science and technology, where Latin America and the Caribbean stand out for their poor results.

Taking into account the role that universities must play in the development of science and the training of researchers, the authors of the project infer that there is a social problem that must be addressed from a scientific point of view, related to the performance of Higher Education. of our region in the formation of the scientific thought of the faculty and the student body.

Young people should have the necessary attitude and aptitude to face everyday problems from positions of innovative science and technology, to facilitate the development of our nations. A small country with adequately trained human resources in science and technology is in a better position to face any challenge; For example, Cuba created five of its own vaccines to deal with COVID-19 and was the first country in the world to vaccinate its entire child population two years and older with a vaccine created and produced in the country.

Therefore, teachers and researchers from four universities have joined this project, in order to approach the problem through a comparative study of their institutions in relation to the process of formation of scientific-investigative thought in each one of them. they. The results they will obtain can contribute to making the authorities of their respective contexts aware of the need to work together to improve this indicator.

In his article *The training of human resources in regional innovation and appropriation of science*, Calderón (2015) presents a proposal for the training of human resources in strategic issues of regional innovation and social appropriation of science, with the

intention of strengthening their practices in research, innovation, technological development, seen as a means that will contribute to the resolution of educational, social and economic development problems in their region.

Other authors such as Rodríguez (coord.); Millares (coord.) (2017) approach the subject with the book *Teacher training from educational research and innovation*, which contains twenty-two contributions on teacher training based on science.

In El Salvador, studies have also been carried out in this regard, among which we can refer as the most recent that of Mendoza (2019), entitled *Science, technology and innovation. Conceptions of teachers in El Salvador*, in which the author identifies the conceptions and beliefs of teachers from the introduction of the Science, Technology and Innovation (CTI) approach, within the framework of the implementation of the National Teacher Training Plan (PNFD), by the Ministry of Education.

Cuban authors such as Baranda (2020), with the article "Teacher support system from a virtual teaching-learning environment", defend the criteria that research, innovation, generation-transfer of knowledge and social responsibility enable sustainable human development.

Another country with an interesting position in this regard is Nicaragua, in the person of López (2016), from the National Autonomous University, in the article "Actors and scenarios in the reformulation of science, technology and innovation policy in Nicaragua", where he states that in the country there is a conceptual "noise" about innovation, and innovation systems and the actors have not yet reached a consensus for the construction of the National Innovation System (SNI) policy. It is concluded that the government model of creating dialogue, consensus and alliance is an opportunity to be taken by the actors involved.

As can be inferred, all the cited authors agree on the importance of research and innovation in the training of university professionals, although they do not refer to the ways in which this competence can be achieved.

The dynamics of the science processes that occur in the 21st century have multiplied the interest of institutions and the general public to deepen their study, hence the scientific publications in mainstream journals and invention patents have become in the main indicators to calculate the ranking of a university, research, scientific or intellectual center of any branch of knowledge. Parents, before enrolling their children in Higher Education, consult their H index in *Google Scholar* and/or find out about the position it occupies internationally through the *WOS* or *Scopus*, which in turn calculate it based on based on the number of citations to articles published in the journals indexed in their databases.

Such social recognition of the value of science is fundamentally based on the development of scientific thinking and the role it has played in transforming the quality of life of people and the sustained growth of the GDP of the nations that invest the most in science. she.

Therefore, it constitutes a duty of governments and of Higher Education in particular, to study the ways to train in their cloisters and in their students what praxis recognizes as a trump card: scientific-investigative thinking.

Although the history of humanity has been very prolific in thinkers from all branches of knowledge, the explicit emergence of a scientific thought properly speaking is attributed to Alberto Magno (1193-1280), a Dominican friar and praised naturalist who lived in France in the thirteenth century. In his method of study, the requirement of observation was imposed, the experiment as the only reliable way of verifying reality. He taught at the University of Paris, from where

he disseminated his ideas about research in the natural sciences.

No less important was Roger Bacon (1214-1294), a Franciscan who was accused of esotericism because he went too far into the future and spoke of ships without rowers, flying machines, automobile cars, and devices for traveling on the bottom of the sea. Despite this, he is remembered for being a brilliant theologian and the first European to formulate the principles of the scientific method that would serve as the basis for the Copernican revolution three hundred years later (Rincón, 2009).

magnifying figure of scientific thought burst onto the scene : Isaac Newton (1643-1727). In that year he published his *Mathematical Principles of Natural Philosophy*, which forever changed the history of science. Although the Renaissance had already known notable names such as Copernicus (1473-1543), Galileo (1564-1642) and Kepler (1571-1630) (authors of the principles of heliocentric cosmology and the movement of the planets); Neper (1550-1617) and Pascal (1623-1662) (symbolic methods in the study of mathematics); William Gilbert (1544-1603) (study of magnetism) and many others, the growing prestige of Newton, who saw some essential aspects of his theory of gravitation corroborated by experiments, dominated the scientific thought of his time.

However, the science that seemed immovable in the 19th century was dwarfed by the avalanche of innovative ideas of the 20th century. Such changes were based on the scientific methods that had preceded it, such as experimentation with increasingly complex instruments and the mathematical foundations as essential scientific language.

Of great importance was the rise of the communication of science with the emergence of the IMRyD method (Introduction, Methodology, Results and Discussion) as a common structure in the writing of articles and the multiplication of the number and diversity of scientific journals, which made possible the diffusion of the results obtained by researchers from other latitudes, which hastened the advancement of technology and the proliferation of new discoveries contributed by science.

Einsten 's theory of relativity (1879-1955), formulated in 1905 and refined in 1915, and quantum mechanics, attributed to multiple researchers, each of whom contributed something to its creation (Niels Bohr, Weiner Eisemberg, Louis de Broglie, Wolfgang Pauli, Paul Dirac and others) are considered the most notable. However, mathematics, increasingly complex, continued to grow as an essential support for new scientific discoveries (Rincón, 2009).

But the 21st century cannot be surpassed in terms of the development of scientific thought by any of its predecessors, due to the growing accumulation of new technologies that have entered the daily life of human beings, atomic fission and fusion, the transformation of metals, robotics, semiconductors and electronic chips, the internet as a paradigm of globalization and the metaverse as a new scenario.

In spite of everything, universities have not always been proactive enough in the formation and development of scientific-investigative thought, an issue that affects the recognition of the quality of the processes they develop.

Educators, pedagogues and leaders of international educational policy agree on the need to strengthen scientific thinking in students, based on a scientific education that is based on a conception that goes beyond the traditional teaching model, generally focused on the repetition of disciplinary content. , to focus on achieving the scientific literacy of children, adolescents and young people, particularly in developing countries, which contributes to the construction of a scientific culture (Furman, 2020).

For Fourez (cited in Furman, 2020), scientific literacy is defined as the "set of knowledge, skills, abilities and mental habits associated with Science that are considered necessary for insertion into contemporary society" (p. 6); the author himself considers it the basis of scientific thought.

In relation to their training, different positions and teaching and learning methodologies coexist, which generally differ in the purpose of their promoters. In the first place, there are those focused on strengthening particular skills such as control of variables and argumentation. These are considered relevant within the standards of science in the international field (Murphy *et al.*, 2018).

Secondly, there are those focused on teaching by inquiry, which is one of the approaches most promoted by science didactics (Soysal, 2021). Vázquez-Alonso and Manassero -Mas (2018) are based on the perspectives of other researchers and indicate that methodologies such as research, projects, problem solving, technology-mediated learning, interactive, social and cooperative learning, allows students to approach scientific literacy, which represents the first step on the road to developing the ability to think scientifically (Martínez, 2022).

The essence of science lies in the consolidation of true learning communities, with innovations in teaching and scientific knowledge to build, rebuild, generate and solve problems with a critical mindset and to achieve the understanding that one learns for life and not for the school. "The university is the center of knowledge that is beyond the scientific method and the experimental model, where science, knowledge and complexity are shown from the individual, as object-subject interaction, the real world and society" (Ruiz Restrepo, Adriana M., and Rivera Pérez, Roberto, 2017, p. 1).

We agree with Krober (1996) when he states: "We understand science not only as a system of concepts, propositions, theories, hypotheses, but simultaneously as a specific form of social activity aimed at the production, distribution and application of knowledge about the objective laws of nature and society".

However, authors such as Argota, Celi and Campos (2019) appreciate limitations for the formation of scientific-investigative thought, for which they consider "The university as an educational institution at the service of society must represent the architect of great changes and promote the introduction on what, how and how much is done, based on scientific knowledge". However, it is necessary to consider four detrimental remarks about the methodological dimension in researchers:

- Limited preparation of teachers to apply scientific methodology in their research proposals.
- Lack of consideration as an objectively verifiable indicator and of sustainable planning, introduce the results.
- Participatory conditioning and monitoring of scientific results.
- Low visibility and insufficient training development in decision makers on the methodology of scientific research (p. 12).

These antecedents confirm the need to deepen the studies about the formation of scientific-investigative thought in Higher Education, which is the object of this investigation.

An approach to the theoretical positions that serve as the basis for the investigation of the object *Formation of scientific-investigative thought in teachers and students of Higher Education based on quality*, leads us to the conceptualization of the construct formation of scientific-investigative thought, associated with psychopedagogy due to its nature of

intellectual process and transformation of the individual from the educational influence.

Leontiev (1989) argues that human activity cannot be examined apart from the system of social relations, from the activity of society. In all human activity, the socially elaborated experience is assimilated: the orientation processes in the object world and its transformations; cultural objects (material and symbolic); the various spheres of knowledge, science, technology, etc.

For this reason, in the research that served as the basis for this article, a central place is given to scientific and investigative training as a support for the teaching-learning processes, the learning process is privileged over the transmission of knowledge (training, not inform), the approach of formative experiences in whose definition and development students and professors intervene, with the incorporation of projects that favor the articulation between teaching-learning and investigative training with an outlet towards society.

Current Higher Education conceives the integral formation of students as a process of interactions whose main objective is to contribute to their professionalization through the articulation of various forms of knowledge and learning situations that allow them to:

- (Re) build their opinions, convictions and images, redo their mental schemes, (re) create knowledge, (re) elaborate ideas and concepts through their own languages.
- Associate the formative experiences with their lives, with the personal and social world.
- Link training practices with the national and global context, giving rise to critical and reflective interrogation of the meanings associated with epistemological, scientific, technical and humanistic knowledge (Prado de Nitsch, 2018).

Likewise, the analysis of the constitutive contents of education is assumed, as formation of the conception of the world, scientific formation and moral formation, which is the treatment that the consulted authors associate with the formation and development of the intellect, as a fundamental support to the compliance with the categories of didactics: problem, objectives, contents, teaching methods and means, forms of organization of the process and evaluation system , as ways of carrying out professional training at an intellectual level.

That is why the scientific approach to the formative processes of the human being has an axiological character that governs the type of link with the development of a certain social conscience, which allows him to self-assess and value the personal and social dimensions as a whole, according to with the interests and values that emanate from their context of action.

Authors such as Álvarez de Zayas (1989) consider that training is the process and the result whose function is to prepare man in all aspects of his personality, it is the possibility and necessity for man to become a subject, to have the ability to consciously dispose of oneself.

On the other hand, thought as a higher form of consciousness, adapts to the level of complexity of human activity, so it is directly proportional to the social and professional functions that each individual develops.

Learning to investigate is developing scientific thinking. According to Prado de Nitsch (2018), scientific research is a professional culture. His characteristic way of thinking is scientific thinking. Investigating is the action or external manifestation of scientific thinking in professional culture. The experiences of professional practice, in themselves, are not scientific or unscientific. What makes a human experience or activity so is the application of the scientific method

to gain understanding of the problem, to answer questions about it, or to verify the results of its application in practice.

In the traditional university model, community service goes hand in hand with research and teaching, so universities are responsible for generating and sustaining scientific research. At the same time, this explains why research does not occur separately from service and teaching (Cheetham, 2007). It is necessary to break with this practice, scientific research as an essential method to address the problems of daily life must be integrated as a competence of Higher Education graduates, hence the importance of working on their training from various spaces.

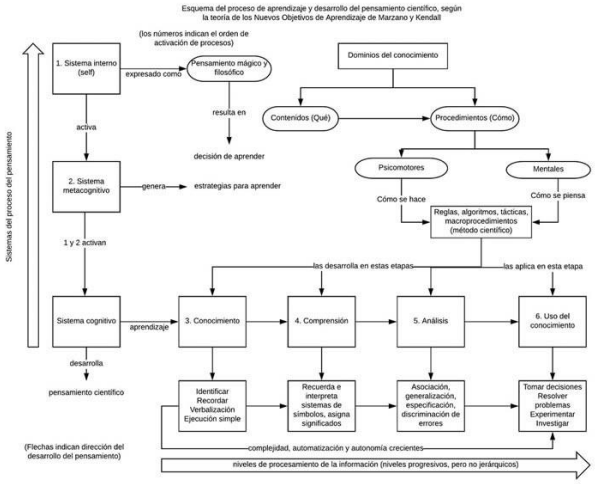
The cycle of development of research and scientific thought begins and restarts, based on new scientific knowledge, professional practice and service to the community. Scientific thinking and the application of the scientific method in research practice transform technical work into scientific work (Prado de Nitsch, 2018 citing Bunge, 1987).

For their part, Jirout and Zimmerman (2015) defend that scientific thinking skills are influenced by the educational, social and cultural context, understanding that, although curiosity is innate, the skills of this thinking are strengthened with intentional educational experiences.

In this way, learning science is one of the relevant aspects to be considered in educational policies, since it promotes critical thinking, reflection, decision-making, observation and communication skills, all of which are understood as skills that enable scientific literacy. (Figueroa *et al.*, 2020).

For Furman (2020), scientific literacy is defined as the "set of knowledge, skills, abilities and mental habits associated with Science that are considered necessary for insertion into contemporary society" (p. 6). It includes the understanding of essential ideas about the functioning of the social and natural world, the process of building knowledge, the appreciation of cultural values and the development of scientific thinking.

With the intention of contributing to the understanding of these judgments, the scheme of the referred process is presented, according to the theory of the New learning objectives of Manzano and Kendall (2007), reinterpreted by Prado de Nitsch (2018).



Source: Meadow of Nitsch (2018)

The authors agree with the way in which the process is represented, although to the domains of knowledge we would add the volitional attitude element, which the authors recognize as essential, so that knowledge is made up of: cognitive elements (content), procedural elements (how I use the content) and attitudinal elements (how I react to it).

The analysis of this scheme leads to the inference that the formation process of scientific-investigative thought is of a complex nature, based on the level and quality of internal (metacognition) and external (formation and use of knowledge) learning. This, in turn, provides increasing automation and autonomy in the application of the scientific method in the analysis and resolution of problems, either within the

framework of the teaching-learning process (curricular), as well as in the context of professional and social performance (extracurricular).

Diaz *et al.* (2020) mention that, in formative development, scientific thinking skills are a central component for the construction of learning to empower educators and transform social environments.

By conceptualizing scientific thought as a type of reflective reasoning that provides rigor to intellectual procedure, three advantages can be established that its development brings to the field of scientific education:

- Promotes thematic or disciplinary understanding,
- favors argumentation in classrooms and laboratories and,
- allows the formation of qualities and competencies that are inherent to intellectual responsibility (Meinguer, 2017).

In this sense, it is relevant to reflect on the ethical and political role that universities play in the development of science from this empowering perspective. Scientific knowledge is pregnant with values and works ideologically. In this way, the work in teacher training around scientific thinking skills will allow building a sense of university social responsibility, both with the training itself and with society as a whole (Gaete, 2015) to, in this way, focus in questioning scientific findings and contributing to improving the quality of life within a framework of rights (Figueroa *et al.*, 2020, p. 268).

According to Cóndor (2020), the COVID-19 pandemic forced educational systems to transition to a pedagogical model in which the process of teaching and assimilation of knowledge is carried out digitally, which led to a more expeditious use of information. research by students.

Another element that must be addressed is the one referring to the quality of Higher Education, one of the demands of the 2030 Agenda; in this case, particularized to the context of the investigation whose results are socialized in this article.

According to Rodríguez (2017), quality assurance advances as a training requirement. It is perceived that quality is no longer focused on products or services to highlight customer satisfaction. Thus, the entire institution is part of quality and must make an effort so that the beneficiaries are the ones who determine if the University has quality or not.

Due to all of the above, in the present investigation the formation of scientific-investigative thought is defined according to quality, as a system of curricular and extracurricular actions conceived by Higher Education institutions and led by the Vice-rectories for Research and/or the Research Directions, which lead to the development of algorithms of the scientific method as a support for the teaching-learning processes in pre- and postgraduate training, materializing in scientific results that solve context problems, both professional and social, and make the university visible, which impacts the subjects involved and the quality of education offered by said institution.

On indicator systems as a scientific result

One of the partial results that was obtained lies in the construction of a system of indicators to evaluate the formation of scientific-investigative thought in Higher Education institutions, adapted to the Central American and Caribbean context, hence it is necessary to deepen at a theoretical level. on this theme.

According to Romero (2010) there are numerous methodologies for the construction of indicator systems, each of which has certain characteristics that have

been given based on the objectives of the research, the characteristics of the process to be evaluated and the vision of reality by the researcher.

For this author, the indicators cannot be considered as simple statistical data that refer to certain aspects of reality, despite the fact that he considers that on many occasions they are treated as such; However, he recognizes that in recent years the way of conceiving and structuring them has changed, which has expanded their applicability, increasingly covering the aspects of complex systems (p. 2).

Tolón, Rivas and García (2011) offer a set of requirements that a system of indicators must meet, which we reproduce for its indisputable value.

Obtaining the information

- Availability. They must be built with existing or available information within a reasonable cost-benefit ratio.
- Representativeness. Certain indicators require the existence of comprehensive statistical series for a sufficiently representative period of time.
- Update. According to the characteristics of the indicator, the information must be updated periodically.
- Balance between scientific-technical indicators and those obtained through processes of social participation. The combination of both types of indicators is usually necessary and convenient, with logical variations depending on the objectives of each system of indicators.

Consistency methodological and scientific validity

- Scientific rigor. They must be based on solid scientific foundations.
- reliability. The data used must not contain doubts about its reliability.
- Consensus. The greatest scientific consensus in the application of the indicators is desirable.
- comparability. Facilitated by consensus, it expands the reference elements, consolidates the application of collection methodologies, generalizes their use and, in short, facilitates the continuous improvement of indicator systems.
- Representativeness. Each indicator must measure a significant aspect of the evaluated area.
- Sensitivity to changes. They must reflect the modifications produced in the different components of the object of study.
- Integration. They must be easily connected with other scientific and technical instruments (econometric models or Geographic Information Systems, for example).
- Adaptation. They must be adapted to the specificity of each study area.

Application and communication

- Comprehension. They must be clear and easy to interpret, both to facilitate their integration into the decision-making processes of public policies and for their social dissemination.
- Simplification. A smaller number of indicators, rigorously selected, facilitates its better understanding and increases the possibilities of application.
- Resonance. Ability to arouse the interest of the agents involved.
- Reference values. Each indicator must be related to reference values or desired levels, with which to compare your current situation.
- Expression of trends. They must indicate the evolution of the values over time in relation to the reference values.

- Integration. They must be integrated into planning and management processes (p. 6).

The authors agree, although in the case of the formation of scientific thought in the faculty and students of Higher Education it is considered necessary to incorporate other essential requirements so that the system of indicators is sufficiently objective and effective. These are:

- Algorithmization: they must stimulate the acquisition of logical steps in correspondence with the scientific method for solving problems in professional or social life.
- Evaluative flexibility: the standards or scales with which the achievements are expressed can be diverse, because the purpose must be that the evaluated subject understands what his zone of proximal development is and what he must do to reach it.

González (2011) presents a methodology for the construction of a system of indicators on the impact of the mobility of personnel employed in science and technology, structured in dimensions and indicators; We will present dimensions 3 and 4 for the level of coincidence with the criteria of the authors of this study in relation to the value of tangible results as indicators to evaluate the development achieved by the formation of scientific thought, in the faculty and students of a university institution.

Dimension3. scientific results

Indicators:

- Number of national or international projects achieved and amount of income.
- Number of publications and articles in national and international journals.
- Number of citations (h-index).
- Awards and recognitions.
- Thesis that advises or evaluates.
- Relevance achieved by the institution.
- Ability to attract economic sources.

Dimension 4. Knowledge transfer results

Indicators:

- patents.
- Patent citations in the literature.
- production of innovations unspoken.
- Introduction of new techniques and methodologies.
- collaborations intersectoral.
- Internationalization (international collaboration).
- Number of items related to the dissemination of knowledge to society.
- Presence in the means.
- Number of users and/or beneficiaries (p. 14).

For his part, Taccari (2012) considers that "Advances in the availability of statistical information on education in the countries of the region allow the construction of these systems, although there are still significant efforts to generate indicators relevant to the educational challenges that faces Latin America as a whole" (p. 1).

Other authors (Begiristain, 2018; Tundidor *et al.* , 2019) have delved into the subject, but with different objects of study, although consulting the methodology followed has provided us with valuable knowledge for the construction of the indicator system that makes it possible to evaluate, in an objective, flexible and contextualized way, the formation of investigative scientific thought in Latin American Higher Education.

CONCLUSIONS

The unquestionable importance of forming scientific thought in university cloisters and their students is unanimously recognized by the world community, although scholars of the subject recognize the profound difference between geographical regions and, particularly, between developed and underdeveloped countries, in crucial aspects such as investment in science and the number of researchers linked to it full time.

Today's world, increasingly fragmented into power blocks, reinforces the need for Higher Education graduates to have scientific algorithms to solve the problems of everyday life. This can only be achieved if adequate training processes are developed within universities, which include Scientific Research Methodology as a mandatory subject in undergraduate study plans and postgraduate programs; convene enough conferences, events, exchanges with research leaders and agreements to solve scientific problems through joint research with companies and service institutions; stimulate the scientific results of the faculty and students obtained inside and outside the institution and allocate resources to promote research.

Definitions about the formation of scientific investigative thought in Higher Education abound, so the authors of this study draw on them to define it as a system of curricular and extracurricular actions, conceived by Higher Education institutions and led by the Research Vice-Rectors and/or Research Directorates, which lead to the development of algorithms specific to the scientific method as a support for teaching-learning processes in pre- and postgraduate training, materializing in scientific results that solve context problems, both professional and social. , and make the university visible, which has an impact on the subjects involved and on the quality of education offered by said institution.

REFERENCES

Argota Pérez, G., Celi Saavedra, L., & Campos Pérez, R. (2019). Política científica universitaria: Pensamiento estratégico. *Revista Campus*, *24*(27), Art. 27. https://www.aulavirtualusmp.pe/ojs/index.php/rc/article/view/1517

Álvarez de Zayas, C. (1989) Fundamentos teóricos de la dirección del proceso educativo en la Educación Superior Cubana. Formato: Libro. Ed: La Paz- Instituto Cubano del Libro. 1ra edición. La Habana, Cuba.

Becerra, A. T., Salvador, P. A. R., & Aguila, V. G. del. (2002). Bases para la construcción de un sistema de indicadores de sostenibilidad para el control y seguimiento de un proceso de desarrollo turístico en Las Alpujarras almerienses. *Comunicaciones presentadas al VI Congreso Internacional de Proyectos de Ingeniería: celebrado en Barcelona del 23 al 25 de Octubre de 2002, 2002, ISBN 84-600-9800-1*, 232. https://dialnet.unirioja.es/servlet/articulo?codigo=8452515

Begiristain Zubillaga, M. (2018). *Comercialización agroecológica: Un sistema de indicadores para transitar hacia la soberanía alimentaria*. Hegoa, Instituto de Estudios sobre Desarrollo y Cooperación Internacional Bilbao Universidad del País Vasco/Euskal Herriko Unibertsitatea UPV/EHU. https://publicaciones.hegoa.ehu.eus/uploads/pdfs/367/Lan_koadernoa_75.pdf?1524730486

Calderón García, R. (2015). La formación de recursos humanos en innovación regional y apropiación de la

ciencia. *RICSH Revista Iberoamericana de las Ciencias Sociales y Humanísticas*, *4*(8), Art. 8.

Cheetham, A. (2007). *Growing a Research Culture*. University of West Sydney. https://www.westernsydney.edu.au/__data/assets/pdf_file/0018/7119/Item_3.6_Building_a_Research_Culture__Tabled_Doc.pdf

Cóndor Herrera, O. (2020). Educar en tiempos de COVID-19. *CienciAmérica: Revista de divulgación científica de la Universidad Tecnológica Indoamérica*, *9*(Extra 2), 31-37.

Figueroa Céspedes, I., Pezoa Carrasco, E., Elías Godoy, M., & Díaz Arce, T. (2020). Habilidades de Pensamiento Científico: Una propuesta de abordaje interdisciplinar de base sociocrítica para la formación inicial docente. *REXE- Revista de Estudios y Experiencias en Educación*, *19*(41), Art. 41.

Furman, M. (2020). *Aprender ciencias en las escuelas primarias de América Latina*. UNESCO Office Montevideo and Regional Bureau for Science in Latin America and the Caribbean. https://unesdoc.unesco.org/ark:/48223/pf0000375199

Gaete Quezada, R. (2015). La Responsabilidad Social Universitaria desde la Perspectiva de las Partes Interesadas: Un Estudio de Caso. *Actualidades Investigativas en Educación*, *15*(1), 273-302.

González Ramos, A. M. (2011). Metodología para la construcción de un sistema de indicadores sobre el impacto de la movilidad del personal empleado en ciencia y tecnología. *Agenda 2011: Temas de indicadores de Ciencia y Tecnología, 2011, ISBN 978-987-20443-2-9, págs. 411-432*, 411-432. https://dialnet.unirioja.es/servlet/articulo?codigo=8154414

Jirout J., Zimmerman C. (2015) Development of science process skills in the early childhood years. In Cabe Trundle,K. and Saçkes M. (Ed.), Research in Early Childhood Science Education. pp. 143-165. https://doi.org/10.1007/978-94-017-9505-0_7

Krober, G. (1986). Acerca de las relaciones entre la historia y la teoría del desarrollo de las ciencias. *Revista Cubana de Ciencias Sociales, IV*(10). https://www.filosofia.cu/?s=Revista+Cubana+de+Ciencias+Sociales%2C+Volumen+4

Lázaro Tundidor Montes de Oca, Medina León, A., Nogueira Rivera, D., Sánchez Macías, A., Carpio Vera, D. A., & Rodríguez Novo, T. de J. (2019). Índice integral de los sistemas informativos para potenciar el sistema de dirección y gestión estatal: Aplicación en una empresa de proyecto del sector de la construcción. *Revista Arquitectura e Ingeniería*, *13*(2), 5.

Leontiev, A. N. (1975). *Actividad, conciencia y personalidad*. Pueblo y Educación. https://omegalfa.es/downloadfile.php?file=libros/actividad-conciencia-y-personalidad.pdf

Martínez-Suárez, D. (2022). Pensamiento científico en la educación secundaria: Acercamiento al estado de la cuestión. *Trilogía Ciencia*

Tecnología Sociedad, *14*. https://doi.org/10.22430/21457778.2150

Marzano, R. J., & Kendall, J. S. (2006). The New Taxonomy of Educational Objectives. En *Corwin Press* (2da ed.). Corwin Press, A SAGE Publications Company.

Meinguer, J. (2019). La comunicación de la nanotecnología del carbono a través del análisis crítico de textos informales en la educación química. *Mundo Nano. Revista interdisciplinaria en nanociencias y nanotecnología, 12*(22). https://www.scielo.org.mx/scielo.php?pid=S2448-56912019000100002&script=sci_arttext

Mendoza, A. (2019). Ciencia, tecnología e innovación: Concepciones del profesorado en El Salvador. *Revista panamericana de pedagogía, saberes y quehaceres del pedagogo*, *27*, Art. 27.

Murphy, P. K., Greene, J. A., Allen, E., Baszczewski, S., Swearingen, A., Wei, L., & Butler, A. M. (2018). Fostering high school students' conceptual understanding and argumentation performance in science through Quality Talk discussions. *Science Education*, *102*(6), 1239-1264. https://doi.org/10.1002/sce.21471

OEI- RICYT (2022) Estado de la Ciencia 2021. Principales Indicadores de Ciencia y tecnología Iberoamericanos. Ed. Altuna Impresores S.R.L. Ciudad Autónoma de Buenos Aires, Argentina. Disponible en: http://www.ricyt.org/wp-content/uploads/2021/11/El-Estado -de-la-Ciencia-2021.pdf

Prado de Nitsch, Fabiola (2018). Aprendizaje, enseñanza y desarrollo del pensamiento científico. *Revista Educación en Ciencias de la Salud, 15*(2) Disponible en: http://www2.udec.cl/ofem/recs/

Ramón López, M. (2016). Actores y escenarios en la re-formulación de la política de ciencia tecnología e innovación en Nicaragua. *REICE Revista Electrónica de Investigación en Ciencias Económicas*, *4*(8), Art. 8.

Rincón Córcoles, A (2009). Evolución del pensamiento científico: del siglo XIII al XXI. *Revista Digital ACTA,* (054), p.p 1-9 https://www.acta.es/recursos/revista-digital-manuales - formativos/92-054

Rivera de Parada, A. (2016). Competencias del docente universitario. Desafíos para las universidades privadas de El Salvador. *Ciencia, Cultura y Sociedad, 3*(1), 33-44. https://doi.org/10.5377/ccs.v3i1.2960

Rodríguez Pérez, R. A., & Miralles Martínez, P. (2017). *Formación del profesorado desde la investigación y la innovación educativa*. Servicio de Publicaciones. https://dialnet.unirioja.es/servlet/libro?codigo=857733

Rodríguez Ruiz, J. R. (2017). El aseguramiento de la calidad de la educación superior. *In Crescendo*, *8*(2), 171-173.

Romero Manrique de Lara, D. (2010). Modelo integrado para la construcción participativa y experta de un sistema de indicadores locales de sostenibilidad. *DELOS:*

Desarrollo Local Sostenible, *3*(9), 1.

Ruiz Restrepo, A. M., & Pérez, R. R. (2017). La ciencia, el conocimiento científico y el pensamiento complejo. El camino para la formación por competencias. *Certiuni Journal*, *3*, Art. 3.

Santos Baranda, Janette (2020), Sistema de acompañamiento docente desde un entorno virtual de enseñanza aprendizaje. *Mendive, Revista de Educación, 18*(1), p.p. 48-63 https://mendive.upr.edu.cu/index.php/MendiveUPR/issue/view/76/showToc

Soysal, Y. (2020). Argument-Based Inquiry, Teachers' Talk Moves, and Students' Critical Thinking in the Classroom. *Science & Education*. https://www.researchgate.net/profile/Yilmaz-Soysal/publication/344283616_Talking_Science_Argument-Based_Inquiry_Teachers%27_Talk_Moves_and_Students%27_Critical_Thinking_in_the_Classroom/links/5f75ac5a299bf1b53e03970d/Talking-Science-Argument-Based-Inquiry-Teachers-Talk-Moves-and-Students-Critical-Thinking-in-the-Classroom.pdf

Taccari, D. Ó. (2010). Mecanismos de monitoreo de los compromisos en educación en América Latina: Sistemas regionales de indicadores educativos. *Sinéctica*, *35*, 1-25.

Vázquez Alonso, Á., & Manassero Mas, M. A. (2018). Más allá de la comprensión científica: Educación científica para desarrollar el pensamiento. *REEC: Revista electrónica de enseñanza de las ciencias*, *17*(2), 309-336.

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