Journal of Infrastructure, Policy and Development 2024, 8(8), 6409.
https://doi.org/10.24294/jipd.v8i8.6409

Article

Semantic networks and scientific knowledge: A comparative analysis across disciplines

Dary Lucia Nieto-Súa[1,*], Nubia Yaneth Gómez-Velasco[2], Ingrid Selene Torres-Rojas[3]

[1] Teacher School of Psychology, Universidad Pedagógica y Tecnológica de Colombia, Tunja, Boyacá 150001, Colombia
[2] School of Mathematics and Statistics, Universidad Pedagógica y Tecnológica de Colombia, Tunja, Boyacá 150001, Colombia
[3] Corporación Universitaria Autónoma del Cauca, Popayán, Cauca 190001, Colombia
*** Corresponding author:** Dary Lucia Nieto-Súa, dary.nieto@uptc.edu.co

CITATION

Nieto-Súa DL, Gómez-Velasco NY, Torres-Rojas IS. (2024). Semantic networks and scientific knowledge: A comparative analysis across disciplines. Journal of Infrastructure, Policy and Development. 8(8): 6409. https://doi.org/10.24294/jipd.v8i8.6409

ARTICLE INFO

Received: 14 May 2024
Accepted: 31 May 2024
Available online: 22 August 2024

Abstract: This study analyzes in a comparative way the psychological meanings that social science and basic science researchers assign to the term "research". Using the Natural Semantic Networks technique with 127 participants from a Colombian public university, we sought to unravel the distinctive epistemological and methodological positions between these disciplines. The findings reveal that, although both groups closely associate research with knowledge, they differ in the lexical network and associated terms, reflecting their different epistemological approaches. Basic science researchers emphasize terms such as "innovation" and "experimentation," while social science researchers lean toward "solving" and "learning." Despite the variability in the associated words, "knowledge" remains the common core, suggesting a shared basis in the perception of research. These results show the importance of considering disciplinary differences in research training and knowledge generation. The study concludes that research contributes significantly to both the advancement of individual disciplines and social welfare, urging future research to explore these dynamics in broader contexts to enrich interdisciplinary understanding and foster cooperation in knowledge generation.

Keywords: psychological meaning; research; semantic networks; social sciences; basic sciences

1. Introduction

Research is a cornerstone in the development and consolidation of educational policies that seek to raise the quality of higher education. In this area, the role played by epistemological and methodological differences between the Social Sciences and the Basic Sciences is fundamental, not only for the generation of knowledge but also for the training of researchers capable of addressing contemporary challenges from innovative and multidisciplinary perspectives.

Understanding perceptions of the word 'research' is crucial to the scientific community because these perceptions shape not only research methodology and approaches, but also the formation of educational policies and programs that seek to foster innovation and the advancement of knowledge. The word itself encapsulates a range of meanings and expectations that vary significantly across different disciplines and levels of expertise, directly influencing how researchers conceptualize and prioritize their work. This understanding is especially important in an academic and professional environment that increasingly values transdisciplinarity and collaboration across fields.

This study is set in the context of a growing interest in understanding how

research is conceived within different academic disciplines. The need for this understanding has become more apparent as universities and research centers seek to foster interdisciplinarity and transdisciplinarity, recognizing that the complex problems of today's world require approaches that transcend traditional boundaries of knowledge.

In agreement with Czarnocka (2019), who argues that science is universal in its basic aspects related to knowledge, cognitive values and arises from a cultural base common to all cultures, this study seeks to approach the psychological meanings that researchers in the Social Sciences and Basic Sciences give to the term "research". This analysis is based on the premise that each hypothesis or research problem needs a context that gives meaning to both the research activity itself and its findings, which implies a conscious and strategic choice by the researcher about what and how to investigate Osca-Lluch and González-Sala (2017), which generates an increase in the number of scientific articles resulting from research processes (Ballesteros et al., 2022; Gómez-Velasco, 2020; Rodríguez-Gutiérrez et al., 2017).

Considering the relevance of epistemological paradigms in the construction of scientific knowledge, this work is aligned with Kant's position, for whom there is no single scientific knowledge, but rather each scientific epistemology offers both procedures and differentiated ontological elements (Walach, 2020). Thus, the study addresses the diversity of approaches and conceptions that characterize the Social Sciences and Basic Sciences, for an approach that allows understanding common and differentiating elements in the conception of the act of research.

In view of these elements, the objective of this article is to analyze comparatively the psychological meanings that researchers in the Social Sciences and Basic Sciences attribute to the term "research", considering the variations according to the area of knowledge and the role within their respective research groups. This study seeks to unravel the epistemological and methodological positions underlying the research practice, evidenced through the technique of Natural Semantic Networks (NSN), in order to identify both common and differentiating elements between these two scientific domains.

Although Semantic Networks have been introduced decades ago, this technique maintains its relevance and applicability in contemporary academic research with promising results in various fields, as shown in studies by Christensen and Kenett (2021), Milfont (2010) and Zinoviev et al. (2016). Research such as Golberg (2015), has delved into the analysis of semantic networks, specifically in the associative strength between words and neural network models for natural language processing. In this context, the approach used in this research allows us to understand how a retrospective relationship is established between terms, that is, the tendency to connect a word with another related word within a predefined list. This study was carried out with participants from the exact, biological and human sciences, highlighting the transversality of the method in different disciplines.

Addressing the topic of semantic networks leads to explore how memory is structured and processed, as well as to analyze psychological meaning from a descriptive perspective of human behavior. The latter involves an introspective and dialectical analysis that integrates anticipation in its linkage to research activity. This analysis highlights how cognitive processes are influenced by academic and cultural

particularities, evidencing that cognition is shaped by the social context in which the individual develops. The semantic networks methodology allows revealing distinctive characteristics and practices of various disciplines in different populations and communities. This methodological approach will make evident the importance of understanding the concept of "research" from a conceptual perspective, especially among those engaged in the generation of scientific knowledge, both in the Basic Sciences and in the Social Sciences.

This research aims to deepen the understanding of how experience and context influence the conceptualization of "research", thus contributing to the collective construction of scientific knowledge and its application towards the development and improvement of the quality of human life. Additionally, it seeks to contribute to the field of knowledge by offering a comprehensive view of the similarities and divergences in the psychological meanings of the concept of "research" between two major areas of knowledge, thus providing important aspects for the design of research training policies and programs that recognize and value these differences.

By understanding how different disciplines perceive the act of research, we can enhance interdisciplinary collaboration and develop educational approaches that foster a more integrated and flexible understanding of the research process. This is particularly relevant in a world where global challenges demand scientific cooperation that crosses traditional boundaries of knowledge. Finally, with respect to the objective proposed in this research, by focusing on the answers given by the participants by area of knowledge and the role within the research groups, differences and similarities in the conceptions of "research" are revealed, and proposals are generated with a view to understanding how these perceptions influence the practice and its scientific role.

The results obtained, which will be discussed throughout this paper, suggest contributions to the understanding of these epistemological and methodological dynamics, thus contributing to interdisciplinary dialogue and the development of effective strategies for the training of researchers; revealing the broad complexity of how research in Basic Sciences and Social Sciences is conceptualized; which reinforces the need to continue exploring these perceptions in broader contexts.

1.1. Theoretical framework

1.1.1. Basic Sciences and Social Sciences: Definitions and distinctions

The understanding of scientific knowledge, fundamental to this study, begins with the differentiation between the Basic Sciences and the Social Sciences. The Basic Sciences, focused on increasing knowledge about fundamental principles of nature, are identified by their focus on the existence and in-depth analysis of the discipline itself (Moon and Blackman, 2014). According to the OECD classification, supported by UNESCO (1979), these disciplines include Mathematics, Physical Sciences, among others, which focus on the study of nature from a purely scientific perspective.

The Social Sciences deal with the study of the objective facts of society, analyzing human beings in their social context through the scientific method (Comte, 2008; Simonton, 2009). This distinction underlines the diversity of approaches and the need to understand the methodological and epistemological specificities that characterize each area.

The conceptualization of scientific disciplines and science itself is deeply influenced by various epistemological positions, ranging from positivism to humanism. This dichotomy, highlighted since Kuhn's (1962) seminal work, shows the tension between the objectivity attributed to the Basic Sciences and the subjectivity inherent to the Social Sciences. This debate reflects not only methodological differences, such as the use of mathematical and experimental analysis in hard sciences, but also the influence of the observer's perception on theoretical assessment, thus marking an ongoing dialogue on the nature of science and its practice (Nieto-Súa et al., 2016).

1.1.2. Psychological meanings in research

The debate on the classification of sciences extends to how research processes are conceptualized and experienced by researchers, involving the construction of meanings in the act of researching. Authors such as Bruner (2012) and Gergen (2018) have emphasized that meaning is a construction, largely social, that shapes reality in a direct way, supporting the idea that scientific knowledge is built through individual and collective interpretation of reality.

These approaches are close to a socio-constructivist explanation of reality, which violates the concept of pure science. By evaluating the meaning of a term or verbal or behavioral expression of the individual, not only are the characteristics that the term has acquired during the individual's life obtained, but also the motivational qualities that guide individual actions within a culture are known. For Shull and Saken (1995), meaning is the union of the self and the object or event, that is, it is the interpretation that the individual makes dynamically in social life within a historical context.

1.1.3. Natural Semantic Network techniques

The Natural Semantic Networks (NSN) technique, proposed by Figueroa-Esteva (1980) and developed by Valdez (2000), is presented as an effective method to explore how meanings are structured and related in the minds of individuals. This technique makes it possible to visualize how specific concepts, such as "research", are understood within specific scientific communities, reflecting the cognitive structures underlying research practice.

The NSN—Natural Semantic Network is based on the idea that concepts and their interrelationships in semantic memory build a network that facilitates the understanding of reality (Vera-Noriega et al., 2005). That is, a set of representations of general concepts, which allow the organization of knowledge through words and verbal symbols, interrelated as conceptual nodes that give rise to more general concepts necessary for the development of language; this interaction is what gives rise to semantic networks, a technique used in various investigations (González-Palacios et al., 2018; Krenn and Zeilinger, 2019).

This approach aligns with studies demonstrating how learning and semantic memory play a crucial role in the formation of meaning networks, suggesting a learning mechanism based on preferential links (Hills et al., 2009).

Thus, semantic memory, a fundamental concept within the Semantic Networks technique, is that internal interpretation that the individual makes to construct reality, and through experiences, predictions and causalities that are connected within new combinations.

The concept of semantic distance introduced by Rips et al. (1973) refers to the proximity existing between concepts according to the groupings of semantic features given by the subjects. Therefore, the NSN technique is a linguistic categorization referring to the mental process by which speakers discriminate the world around them into different categories.

Under these conceptualizations, the concept of categorization emerges from the mode of interaction of speakers—with each other and with the world—within a given culture and from the general cognitive processes involved in conceptualization (Hay et al., 2017; Terniievska, 2022).

2. Materials and methods

A study of a non-experimental nature was carried out, applying the Natural Semantic Networks (NSN) technique as described by Valdez (2000). This methodology is recognized for its ability to integrate quantitative and qualitative aspects, as noted by Sánchez-Martínez (2012), which continues to be a methodological strength applied in various investigations (Antosz et al., 2022). The technique allows the identification of the words that participants use to define the research activity, thus facilitating the understanding of the underlying psychological meaning. Quantitative elements are derived from the numerical data collection specified by Nieto et al. (2016), including:

J-value: Reflects the total number of defining terms contributed by participants, providing a measure of the semantic breadth of the conceptual network.

M value: Indicates the semantic relevance assigned to each defining term, based on a hierarchy system.

SAM group: Denotes the set of terms that receive the highest M values, highlighting their central importance in the semantic network.

FMG value: Measures the semantic distance between terms, expressed in percentages, which allows understanding the conceptual relationship between the defining words.

G-value: It indicates the conceptual density and shows the proximity between successive terms in the network, calculated from the *M*-value.

To facilitate the understanding of the methodology employed in our study, **Figure 1** illustrates an outline of the systematisation of the information and the formulas used.

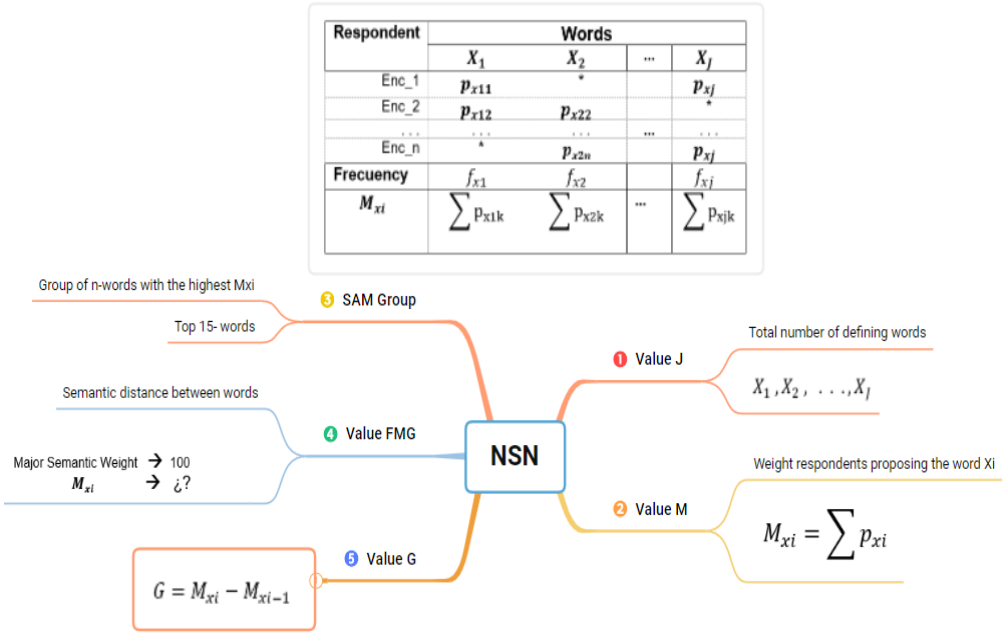


Figure 1. Methodological outline and formulas used in the study (Source: Own elaboration).

2.1. Participants

The selection of participants was carried out by means of a non-probabilistic and voluntary sampling, totaling 127 researchers, both men and women. This group included 76 professionals from the Basic Sciences and 51 from the Social Sciences, all affiliated to a Colombian public university with institutional accreditation.

The representation of research groups reached 70% and 52% for each area respectively, ensuring a broad coverage of the research spectrum. The categorization of the groups followed the measurement model established by the Colombian Ministry of Science, Technology and Innovation. The determination of the number of researchers and the assignment of their roles within each field was based on a quota system, proportional to the size of the population studied (**Table 1**).

Table 1. Participants according to sex, age, time of experience (Source: own elaboration).

	Features	**Participant (% sample)**	**Experience time**
Basics Science	Sex: Female: 33 Male: 42 Ages in years and (sample %) 18 to 23 → (38.1%) 24 to 30 → (28.9%) Over 30 → (33%)	Coordinator (22%)	Average 18 years old
		Principal Investigator/Co-Investigator (32%)	Average 6.5 years
		Young researcher (14%)	Average 2.5 years
		Research seedbed (32%)	Average 1.6 years
Social Science	Sex (One respondent refused to specify his or her gender): Female: 25 Male: 26 Ages in years and (% sample) 18 to 23 → (25.5%) 24 to 30 → (15.7%) Over 30 → (58.8%)	Coordinator (28%)	Average 13.6 years
		Principal Investigator/Co-Investigator (32%)	Average 7.7 years
		Young researcher (12%)	Average 1.5 years
		Research seedbed (28%)	Average 1.5 years

In Basic Sciences, 81.8% of the coordinators surveyed have at least a doctoral

degree, 56% of them from foreign universities. In Social Sciences, 50% of the coordinators surveyed have doctoral degrees, 57% of which were obtained at foreign universities.

2.2. Instrument and application

The instrument used in this study was the Natural Semantic Networks (NSN) technique, as defined by Valdez (2000). This technique was implemented with the objective of revealing and analyzing the set of terms that researchers, both in Basic Sciences and Human Sciences, associate with the concept of research. This process is based on a reconstruction of the information, starting from the meanings attributed to their actions during the research. Ormrod (2005) argues that psychological meaning emerges both from personal attributions and from the social construction of meaning, influenced by the social and cultural environment of the individual; where identity reflects descriptive and self-organizing characteristics of a subject in a social context (Pliushch, 2023).

The application of the NSN technique is structured in two key phases: a) the selection of a 'stimulus' word, in this case, 'investigate', which the participants must propose using ten other words that, in your opinion, are associated with 'stimulus'. These can be nouns, adjectives or verbs; and b) the ranking of these defining words on a scale of 10 to 1, where the value 10 indicates the maximum conceptual closeness to the stimulus.

For the implementation of the NSN technique, each participant was individually invited to define the word 'investigate' by choosing ten related words that reflected their understanding and perception of the concept. The responses were then ranked by the participants from 1 to 10. This ranking helped to assess the relative importance of each associated term.

The application of the technique was carried out personally and individually, in the facilities of the university center. The average time used by each participant was 12 min.

This methodological approach allows for a more in-depth exploration of the perceptions and mental associations that researchers establish with the research activity.

2.3. Data analysis

The data collected were analyzed using SPSS V.21 statistical software to determine the frequency and relevance of each term within the semantic networks formed. The mean and standard deviation were calculated for each term and correlation analysis was used to compare the network structures between the Social Sciences and Basic Sciences. The most frequent and weighted terms were identified and discussed in relation to their epistemological implications.

Within the analysis of the information, there are two values that define the semantic network and will be of central interest in the results, these being the *J*-value, which represents the total number of defining words contributed by the participants. According to Valdez (2004), this value serves as an indicator of the semantic richness of the network, suggesting that the greater the number of words generated, the greater

the perceived semantic richness.

Complementarily, the *M* value, which estimates the semantic weight of each defining word based on its hierarchical position assigned by the participants. The analysis of this value reflects the relative importance that subjects attach to each term, with words with greater semantic weight being considered to capture more accurately the meaning that the group attributes to the stimulus word. The words that make up this group with greater weight are grouped into what we call the SAM (Semantic Association Memory) group, which is fundamental to understanding how meaning is structured around the term analysed.

3. Results

For a better organization, the results are organized in three sections, in order to provide the findings on how researchers in the two areas of knowledge conceptualize "research". The first focuses on the initial comparison of the lexical networks between basic and Social Sciences and highlights the common keywords; the second addresses the differences found and highlights the unique terms; finally, the conceptual density between the defining terms according to the role of the researcher is presented comparatively in each area of knowledge.

3.1. Lexical structure and commonalities between the Basic and Social Sciences

In the application of the Natural Semantic Networks (NSN) technique, the first indicator obtained corresponds to the *J* value, which reflects the total number of defining terms associated with the concept of research. There were 368 terms from participants in Basic Sciences and 290 in Social Sciences.

The average *J*-value analysis revealed that respondents from Social Sciences present a broader lexical network (average 5.80) compared to those from Basic Sciences (average 4.84), evidencing an average difference of 1.04 in research-related lexical "research".

To identify the SAM group, the 15 most relevant words were selected, following the methodology described by Valdez (2000). The detailed analysis, represented in **Table 2**, highlights that "knowledge" is the predominant term in both fields, although with different semantic weights: 170 in Basic Sciences versus 75 in Social Sciences. This suggests variations in the perception of the value of "knowledge" between disciplines.

The terms that make up the MAR group illustrate the priorities of researchers in each area with respect to "research". Notably, "innovation" ranks second for Basic Sciences participants, but drops to fourth in Social Sciences. On the other hand, "inquiry" rises to second place in Social Sciences, while in Basic Sciences it is in thirteenth place, revealing significant differences in the hierarchy of concepts associated with "research" between these two areas of knowledge.

In the analysis of the semantic network associated with the SAM group, the five most significant keywords for participants in both fields of study were identified. For the Basic Sciences, these key terms are: "knowledge", "innovation", "hypothesis", "analysis" and "science". Meanwhile, in the Social Sciences, the most prominent

terms are: “knowledge”, “inquiry”, “analysis”, “innovation” and “science”. This selection reflects points of convergence and divergence in the conceptualization of “research” between the two disciplines.

Table 2. SAM group and valor *M* (Source: Own elaboration).

Basic Sciences		**Social Sciences**	
Definers	***M*-value**	**Definers**	***M*-value**
Knowledge	170	Knowledge	75
Innovation	131	Inquire	75
Hypothesis	124	Analysis	53
Analysis	123	Innovation	50
Science	104	Science	48
Observation	79	Hypothesis	47
Methodology	77	Methodology	39
Experimentation	75	Discover	39
Results	73	Method	36
Development	68	Problem	31
Problem	62	Dedication	30
Curiosity	55	Technology	28
Inquire	54	Meet	27
Dedication	54	Search	27
Objectives	51	Learning	26
J = 368 defining words		*J* = 290 defining words	

3.2. Differences in conceptual association by discipline

The comparison of hierarchical weight, measured by *M* values, reveals notable differences in the lexicon used by both groups. In particular, “observation” emerges as a relevant term exclusively in the context of the Basic Sciences, appearing within its SAM group, but absent in the lexical corpus of the Social Sciences. Contrastingly, “discover” occupies a significant position in the Social Sciences, ranking eighth, while in the Basic Sciences it is not only absent from the SAM group, but also occupies a distant position, at 134th place within its lexical network. Despite these differences, there is a 60% degree of coincidence in the defining terms between the two fields.

The study also conducted a correlation analysis to compare the importance assigned to the terms by Basic and Social Science researchers. Using Spearman’s Rho coefficient, a correlation of 0.56 with a *p*-value of 0.112 was found, suggesting that there is no statistically significant correlation between the hierarchies of importance that participants from both fields assign to terms. This result indicates underlying differences in the prioritization of research-related concepts between the basic and Social Sciences.

In relation to the *G* value, as detailed in **Table 3**, Basic Sciences participants exhibit a remarkable 39-point difference in conceptual density between “knowledge”, the primary term, and “innovation”, the second most important term. In contrast, in the Social Sciences, “knowledge” and “inquiry” emerge as the primary defining words

with no difference in conceptual density ($G = 0$), underscoring an integrated view of these concepts in relation to "research".

Table 3. FMG value and *G* value (Source: Own elaboration).

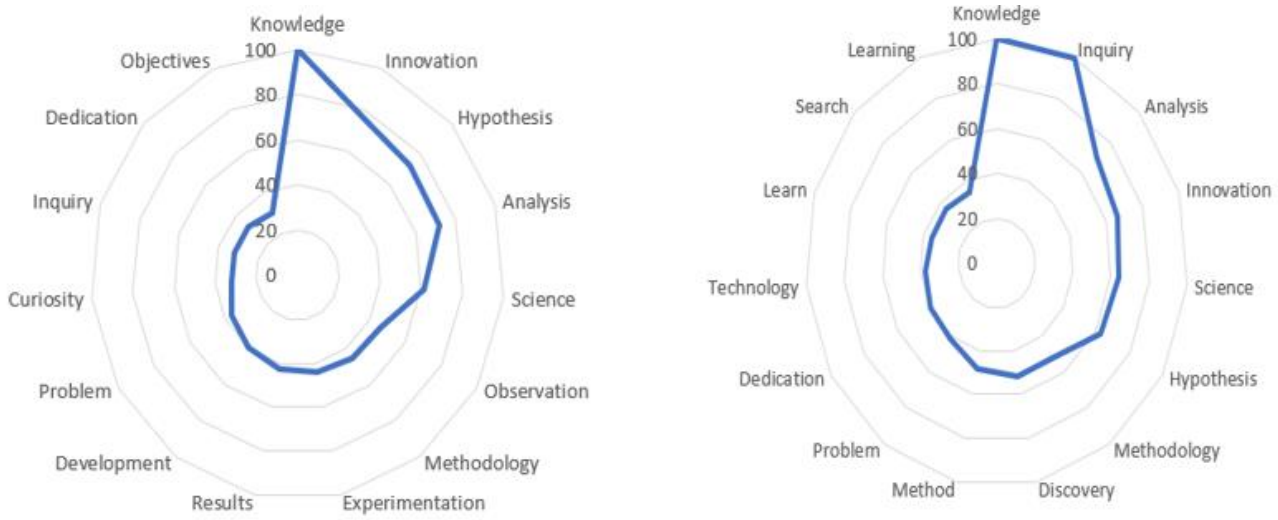
Basic Sciences			**Social Sciences**		
Definers	**FMG value**	***G*-value**	**Definers**	**FMG value**	***G*-value**
Knowledge	100	0	Knowledge	100	0
Innovation	77.1	39	Inquire	100	0
Hypothesis	72.9	7	Analysis	70.7	22
Analysis	72.4	1	Innovation	66.7	3
Science	61.2	19	Science	64	2
Observation	46.5	25	Hypothesis	62.7	1
Methodology	45.3	2	Methodology	52	8
Experimentation	44.1	2	Discover	52	0
Results	42.9	2	Method	48	3
Development	40	5	Problem	41.3	5
Problem	36.5	6	Dedication	40	1
Curiosity	32.4	7	Technology	37.3	2
Inquire	31.8	1	Meet	36	1
Dedication	31.8	0	Search	36	0
Objectives	30	3	Learning	34.7	1

This difference is also evident in the overall conceptual density, where Basic Sciences show a dispersion of 39 points between "knowledge" and "innovation", contrasting with the 25 points observed in Social Sciences between the same terms, reflecting variations in the conceptual interconnection within each field.

In addition, the dispersion analysis for *G* values reveals a greater thematic cohesion among Basic Sciences researchers, compared to those in Social Sciences, where "knowledge" and "inquire" share the same semantic distance ($G = 0$), and the greatest disparity is observed between "analysis" and "inquire" ($G = 22$).

Table 3 and **Figure 1** quantitatively illustrate these semantic distances (It is important to clarify that the semantic distances mentioned above were calculated specifically in relation to the word with the highest semantic weight Mxi. This allows for an explicit and direct understanding of the semantic associations between the most weighty and other relevant concepts in each group studied), highlighting "knowledge" as the central axis of the semantic network for both groups, although with a semantic distance of 100% in Basic Sciences. In Social Sciences, both "knowledge" and "inquiry" function as central nodes, both reaching the same percentage of centrality (100%), which demonstrates the preeminence of the term "knowledge" in the conceptualization of research in both disciplines.

For purposes of better visualization, **Figure 2** shows the FMG values for Basic Sciences and Social Sciences, thus showing the percentage differences and the particular behavior in each of the sciences (**Figure 2a,b**).



(a) **(b)**

Figure 2. FMG value; **(a)** FMG value Basic Sciences; **(b)** FMG value Social Science (Source: Own elaboration).

3.3. Conceptual density between areas according to the researcher's role

Analysis by role within research groups reveals distinctive patterns of commonalities and differences in the use of defining terms between the Basic and Social Sciences.

In the seed groups, nine common terms stand out, including "objectives", "hypothesis", "methodology", "analysis" and "development", indicating a shared basis in the initial understanding to "research" (**Table 4**). However, divergences are noted: basic science seedlings focus on "innovation", "results" and "scientific method", while social science seedlings emphasize "solve", "learning", "inquiry" and "conclusion", reflecting differences in early research orientation.

Table 4. Stimulus defining words by role and assigned hierarchy (Source: Own elaboration).

Role	Basic Sciences	Social Sciences
Research seminars	Knowledge, hypothesis, methodology, innovation, curiosity, results, objectives, analysis, science, scientific method, development, question, dedication,	Knowledge, methodology, development, solving, learning, hypothesis, analysis, curiosity, conclusion, inquiry, dedication, variables, objectives, science, discovery.
Young researchers	Knowledge, innovation, observation, analysis, science, discipline, responsibility, discussion, solutions, learning, information, problem.	Hypothesis, innovation, knowledge, inquiry, variables, science, glimpse, ethics, rationale, periodicals, systematics, bibliofigurey, search, constructs, problem.
Researchers	Hypothesis, innovation, knowledge, analysis, science, experimentation, observation, results, development, training, methodology, technology, problem.	Method, analysis, knowing, diagnosis, proposal, discovery, contributions, science, relate, inquiry, problem, technology, knowledge, understanding, creation.
Group directors (coordinator)	Knowledge, analysis, inquiry, experimentation, science, search, problem, theory, innovation, scientific method, articles, curiosity, compare, question, conceptualize.	Dissemination, knowledge, innovation, read, discover, science, create, analysis, search, dedication, know, transfer, investigate, find, results,

Note: the words in bold are coincident between the two sciences within the same role.

Among young researchers, agreement decreases to four fundamental terms: "knowledge", "innovation", "science" and "problem", indicating a growing thematic specialization and divergence. The Basic Sciences assign greater importance to "observation", "analysis" and "discipline", while the Social Sciences value "method",

"knowing" and "diagnosis", underlining different approaches in the consolidation of their fields of study.

Established researchers share key terms such as "knowledge," "analysis," "science," "technology," and "problem," suggesting a consensus on essential elements of "research". However, the Basic Sciences prioritize "hypothesis," "experimentation," and "observation," in contrast to the Social Sciences, which focus on "method," "proposition," and "discover," evidencing profound differences in the approach to advanced research.

Finally, the coordinators or directors show a breadth of shared terms, such as "knowledge", "analysis", "inquiry", "science" and "innovation", highlighting an integrative vision of "research". However, the distinction remains; the Basic Sciences emphasize "experimentation" and "theory", while the Basic Sciences emphasize "experimentation" and "theory", while the Basic Sciences emphasize "experimentation" and "theory", Social Sciences emphasize "disseminate", "read" and "create", reflecting variations in the leadership and direction of the research groups.

This detailed analysis shows how, despite the common basis in the valuation of "knowledge" and other fundamental terms, the specific orientations of each group and discipline reflect intrinsic differences in the perception and prioritization of research activity, from initial training to research leadership.

4. Discussion

The central purpose of this study was to explore and compare the psychological meanings attributed to the concept of "research" by academics in the social and Basic Sciences. Using the Natural Semantic Networks (NSN) technique, it was revealed that, although certain terms are common to both groups, each discipline tends to focus on distinctive aspects of the research process. Basic science researchers emphasize elements such as innovation (131), hypothesis (124), and analysis (123), reflecting an inclination toward more structured and experimental approaches. In contrast, social science practitioners place greater emphasis on inquiry (75), analysis (53), innovation (50) suggesting a more open-ended and exploratory approach to "research". This divergence highlights the persistent duality between scientific and humanistic perspectives, underscoring how epistemological orientation shapes the perception of the research act.

The results show how, despite methodological differences, both fields conceive "research" as an essential means for the advancement of knowledge. This shared vision underlines the intrinsic function of research as a vehicle for learning and conceptual change, aligning with the theories on the integrative role of research in higher education proposed by authors such as Heinz and Maasen (2020) and Strohecker (2018). The convergence in the valuation of knowledge, regardless of the differences in the methodological approach, reinforces the idea that research, in its multiple forms, constitutes a fundamental pillar in the construction of disciplinary and transdisciplinary knowledge. Even though the split between the so-called scientific and humanistic positions, as stated in Nieto et al. (2016), continues to gain value.

The findings also suggest that the interpretation of the concept of "research" is deeply influenced by the epistemological paradigms that predominate in each field

(Omodan, 2022). This indicates that how researchers conceptualize and prioritize aspects of their work reflects not only methodological practices, but also underlying beliefs about the nature of knowledge and how it should be acquired. This study, therefore, not only sheds light on the many facets of scientific research, but also invites deeper reflection on the epistemological foundations that guide our understanding of the world and how we seek to understand it.

The term "research" is closely associated with the field of research and development, as defined by the Organisation for Economic Co-operation and Development (OECD). This association implies the establishment of schemes and the classification of research units according to the specific area of knowledge in which the research work is performed (OECD, 2018). According to the Royal Spanish Academy (RAE), research implies an effort aimed at expanding knowledge in a given field, emphasizing discovery as the central objective of this process (RAE, n.d.).

Beyond the concept of "knowing," the results of the present study reveal a range of semantic meanings associated with "research", including "transform," "innovate," and "analyze," as well as "problem" and "learning." Galeano-Higuita et al. (2015) suggest that research facilitates a deeper understanding of one's discipline through the description, interpretation, and analysis of social and human phenomena in real contexts. Similarly, Stuart and Botella-Trelis (2009) indicate that the use of specialized terms in scientific terminology varies according to the field of knowledge, which contributes to the definition of academic communities and, in turn, these communities define the use of such terms. This dialogue between terms and paradigms suggests different levels of complexity and deepening in the understanding of research (Roll-Hansen, 2017).

It is important to recognize how the role of participants within their research groups influences the psychological meaning attributed to the term "research". This is manifested in a correlation with the time of experience in research; for example, members of research groups tend to use terms aligned with introductory courses on research, such as "objectives", "hypothesis" and "methodology". On the other hand, in the group of young researchers, there is less terminological coincidence between the areas of knowledge, but the terms that stand out-such as "knowledge", "innovation", "science" and "problem"-denote a significant impact on the theoretical contribution.

In the group of researchers, the application of the Natural Semantic Networks (NSN) technique reveals a hierarchy of importance oriented towards scientific contribution, highlighting the relevance of analysis and technology in the research results. This approach is corroborated by the coordinators or directors, who underline research as a vital source of scientific knowledge, highlighting a proactive attitude of inquiry.

The findings suggest that both groups of researchers adopt an approach depending on the phenomenon investigated, resonating with Lévi-Strauss' (1987) observation about the direct interaction of the researcher with the process and results of the research, as well as with the methodology employed. Through the analysis of the psychological meaning of the concept "to investigate", the results show notable differences between the disciplines.

In the Basic Sciences, the concepts "knowledge" and "inquiry" present a clear

distinction, implying that "knowledge" demands a deepening of the subject, while "inquiry" is associated with the initial exploration of scientific knowledge. On the contrary, in the Social Sciences, these terms seem to have similar meanings, suggesting a synergy in the investigative approach, as illustrated in the results obtained, especially in **Figure 2**. Where the FMG values are respectively for Basic Sciences 100 and 31.8, while for Social Sciences the values correspond to 0 and 0, for the word's knowledge and inquiry.

Furthermore, the distinction between the concepts of "search" and "knowledge" enriches the discussion on the semantic bases that differentiate quantitative and qualitative methodologies, indicating that quantitative researchers could operate under a different conceptual framework than the predominant one in the Social Sciences.

Returning to Bruner (2012), it is essential to highlight the active role adopted by the researcher in the knowledge process, significantly influenced by his context and experiences. This active approach, characterized by direct interaction and manipulation of the object of study, differs according to the methodological approach to the phenomenon under investigation. This orientation and the psychological meaning assigned to the concept of "researching" reflect substantial methodological differences between the fields, supported by statistical correlations such as the correlation coefficient, which can be attributed to the training and research trajectory of the participants.

The results derived from this research provide a foundation for formulating questions that explore the implicit theories that guide individual research practice, based on their affinity for the basic or Social Sciences. According to this analysis, the importance of an experiential investigative learning, which is conceived as a constructive and self-regulated process based on experiential experiences, is underlined. Thus, research competencies are developed through educational practice and research experience, fostering the co-creation of new knowledge.

5. Conclusion

Following the analysis of the data collected, fundamental conclusions are reached that underscore the transcendence of the psychological meaning that researchers, regardless of their discipline, attribute to the activity of research. Essentially, the concept of "knowledge" emerges as the central core of research, considered by both groups studied as the primary element most directly related to the act of doing research.

This study reveals that the activity of research transcends the mere acquisition of knowledge to encompass an extensive lexical network that includes analysis, innovation, methodology, motivation, and problem formulation. These components not only enrich the psychological meaning of "research", but also emphasize the complexity of this practice, reflecting the dynamic interaction between the thematic content and the context in which the research takes place.

The findings confirm the crucial contribution of the researchers' psychological perspective in the generation of scientific knowledge. The importance of recognizing not only the procedures and methodologies employed, but also the in-depth analysis and experience of the researcher as determining factors in the research process is

highlighted.

It is observed that the motivation of researchers, whether in Basic Sciences or Social Sciences, to contribute to their field of study or to society in general, highlights the intrinsic value of "research" as a good at the service of humanity, facilitating significant advances for the improvement of the quality of life.

This study also shows the importance of research within higher education policies, demonstrating how the psychological meaning assigned to research activity reveals diverse epistemological and methodological positions. These differences are crucial for understanding the paradigms that guide research in different areas of knowledge, as well as the impact of the researcher's role and experience.

Contributing to the dialogue on interdisciplinarity and transdisciplinarity, the results show significant conceptual divergences in the approach to "research" among the disciplines studied. This underlines the richness and complexity of approaching phenomena from multiple perspectives, enriching the process of knowledge creation.

It is recommended that this research be extended by replicating the study with a larger and more diverse group of participants from different educational institutions, both national and international. This would allow for more robust comparative analyses and would provide important elements for educational and scientific policy makers. Additionally, it is suggested to deepen the meta-analysis of the research process at different formative stages, in order to broaden our understanding of the evolution of the meaning of research throughout the academic and professional careers of researchers.

Finally, it is suggested to explore the dynamics of interdisciplinary research and how researchers from fields that cross the traditional divisions between basic and Social Sciences negotiate and construct shared meanings around "research".

Limitations of the study and future research

While the use of the Natural Semantic Networks technique is useful for this type of study and provides valuable insight into the psychological meaning of "research" across the basic and Social Sciences, it may not capture the full complexities and nuances of such meanings. In addition, the selection of participants from a single educational institution in Colombia may limit the generalizability of the results to different cultural and academic contexts. This study focused on a quantitative and qualitative analysis of the perceptions of researchers specifically from the basic and Social Sciences, which excludes the possibility of exploring these perceptions in interdisciplinary or emerging fields, where meanings and research practices could diverge substantially.

An inherent limitation of this study is the variability of semantic networks between languages, particularly between Spanish and English, which affects the synonym structure and relative frequency of words. Linguistic and cultural differences may alter the composition of the most frequent words in the top 15, and in the interpretation of the data and conclusions of the study. In addition, the translation process was carried out by multilingual human translators, who despite their professionalism, may introduce a subjective bias in the translation, which could affect the semantic interpretation of the results.

The findings of this study open up several options for future research. It would be fruitful to expand this work to a broader and more diverse sample, including researchers from a variety of academic institutions and countries, to examine how cultural and structural differences in the field of higher education may influence the psychological meanings attributed to research. In addition, future studies could employ complementary methodologies, such as in-depth interviews or focus groups, to gain a richer and more nuanced understanding of how researchers experience and conceptualize research practice.

Author contributions: Conceptualization, DLNS and NYGV; methodology, DLNS; software, NYGV; validation, DLNS, NYGV and ISTR; formal analysis, NYGV; investigation, DLNS; resources, ISTR; data curation, DLNS; writing—original draft preparation, NYGV and DLNS; writing—review and editing, ISTR and DLNS; visualization, NYGV; supervision, DLNS, NYGV and ISTR; project administration, DLNS; funding acquisition, NYGV and ISTR. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare no conflict of interest.

References

Antosz, P., Bharwani, S., Borit, M., et al. (2022). An introduction to the themed section on 'Using agent-based simulation for integrating qualitative and quantitative evidence.' International Journal of Social Research Methodology, 25(4), 511–515. https://doi.org/10.1080/13645579.2022.2052651

Ballesteros-Alfonso, A. L., & Gómez-Velasco, N. Y. (2022). Inequality of Saber-11 test scores before and during the covid-19 pandemic (2014–2021) (Spanish). Revista Latinoamericana de Ciencias Sociales, Niñez y Juventud, 20(3), 1–23. https://doi.org/10.11600/rlcsnj.20.3.5189

Botella, A., & Stuart, K. (2009). Corpus linguistics, network analysis and co-occurrence matrices. International Journal of English Studies, 9(3), 1–20.

Bruner, J. (2012). What psychology should study. International Journal of Educational Psychology, 1(1), 5–13. https://doi.org/10.4471/ijep.2012.01

Carnicero, J. A. C., Ormrod, J. E., Sanz, A. J. E., & Soria, M. O. (2005). Human learning (Spanish). Madrid, Spain: Pearson Educación.

Christensen, A. P., & Kenett, Y. N. (2023). Semantic network analysis (SemNA): A tutorial on preprocessing, estimating, and analyzing semantic networks. Psychological Methods, 28(4), 860–879. https://doi.org/10.1037/met0000463

Comte, A., & Martineau, H. (2008). The Positive Philosophy of Auguste Comte. Cambridge University Press. https://doi.org/10.1017/cbo9780511701450

Czarnocka, M. (2019). How Is Science Universal? Dialogue and Universalism, 29(2), 217–238. https://doi.org/10.5840/du201929230

De Albuquerque, F. J. B., Noriega, J. Á. V., & Pimentel, C. E. (2005). Semantic networks: Theoretical, technical, methodologic and analytical aspects. Ra Ximhai, 3(1), 439–451.

Duffy, A., Grealy, M., Hay, L., et al. (2017). Towards a shared ontology: A generic classification of cognitive processes in conceptual design. Design Science, 3. https://doi.org/10.1017/dsj.2017.6

Eslava, S., Gómez Velasco, N. Y., & Nieto Súa, D. L. (2016). Psychological meaning of the concept of "research" in researchers: Psychological meaning of the concept of "research" in researchers (Spanish). Diversitas: Perspectivas en Psicología, 12(1), 109–121.http://doi.org/10.15332/s1794-9998.2016.0001.08

Figueroa Esteva, M. (1980). Principles of language organization (Spanish). La Habana: Editorial Academia.

Figueroa, J. G., González, E. G., & Solís, V. M. (1976). An approach to the problem of meaning: Semantic networks. Journal of Psycholinguistic Research, 5, 107–115.

Fireman, G., Stefanescu, D., Swenson, L., & Zinoviev, D. (2016). Semantic networks of interests in online non-suicidal self-injury

communities. Digital Health, 2, 2055207616642118. https://doi.org/10.1177/2055207616642118

González-Palacios, A., García-Campos, T., Soltero-Avelar, R., et al. (2018). A Methodological Reflection on the Importance-Frequency Method and Natural Semantic Networks in the Study of Social Representations. Available online: http://www.cucs.udg.mx/revistas/edu_desarrollo//anteriores/46/46_Palacios.pdf (accessed on 4 January 2024).

Gergen, K. (2018). The Social Construction of Reality. Social Constructivism as Paradigm? Routledge. https://doi.org/10.4324/9780429467714-17

Galeano-Higuita, C., Gomez Vargas, M., & Jaramillo Munoz, D. A. (2015). The state of the art: a research methodology. Revista Colombiana de Ciencias Sociales, 6(2), 423–442. http://doi.org/10.21501/issn.2216-1201

González-Sala, F., & Osca-Lluch, J. (2017). Scientific networks and research groups development. Educational Psychology case in Spain during the five-year periods 2004–2008 and 2009–2013. Available online: http://hdl.handle.net/10201/72584 (accessed on 4 January 2024).

Goldberg, Y. (2015). A Primer on Neural Network Models for Natural Language Processing. JAIR, 57. https://doi.org/10.1613/jair.4992

Gómez-Velasco, N. Y., Soto Arango, D. E., & Jardilino, J. R. L. (2018). Science and technology policies and measurement in Colombian universities 1992–2014 (Spanish). Pedagogical and Technological University of Colombia. https://doi.org/10.19053/9789586602990.9789586604314

Gutiérrez, J. K. R., Herrera-Martínez, Y., & Velasco, N. Y. G. (2017). Bibliometric techniques in dynamics of scientific production in research groups. Case study: Biology-UPTC (Spanish). Revista Lasallista de Investigacion/Revista Lasallista de InvestigacióN, 14(2), 73–82. https://doi.org/10.22507/rli.v14n2a7

Heinz, J., & Maasen, S. (2020). Co-producing the European higher education area: the (somewhat overlooked) role of the Social Sciences. Studies in Higher Education, 45, 1758–1770. https://doi.org/10.1080/03075079.2019.1617684

Hills, T., Maouene, M., Maouene, J., et al. (2009). Longitudinal Analysis of Early Semantic Networks. Psychological Science, 20, 729–739. https://doi.org/10.1111/j.1467-9280.2009.02365.x

Kuhn, T. S. (1962). The structure of scientific revolutions. Mexico: Fondo de Cultura Económica.

Krenn, M., & Zeilinger, A. (2019). Predicting research trends with semantic and neural networks with an application in quantum physics. Proceedings of the National Academy of Sciences, 117(4), 1910–1916. https://doi.org/10.1073/pnas.1914370116

Moon, K., & Blackman, D. (2014). A Guide to Understanding Social Science Research for Natural Scientists. Conservation Biology, 28(5), 1167–1177. https://doi.org/10.1111/cobi.12326

Martínez, C. S. (2012). Psychological meaning of family, mom and dad in adolescents (Spanish). Psicología Iberoamericana, 20(1), 18–28. https://doi.org/10.48102/pi.v20i1.216

Milfont, T. L. (2010). The psychological meaning of preservation and utilization attitudes: A study using the natural semantic network technique. Psyecology, 1(1), 123–136. https://doi.org/10.1174/217119710790709559

OECD. (2018), Frascati Manual 2015: Guide for the collection and reporting of information on research and experimental development. OECD Publishing. https://doi.org/10.1787/9789264310681-es

Omodan, B. (2022). A Model for Selecting Theoretical Framework through Epistemology of Research Paradigms. African Journal of Inter/Multidisciplinary Studies, 4(1), 275–285. https://doi.org/10.51415/ajims.v4i1.1022

Pliushch, A. N. (2023). Understanding Identity in the Context of Cultural-Historical Psychology (Russian). Psychology. Journal of the Higher School of Economics, 20(2), 338–353. https://doi.org/10.17323/1813-8918-2023-2-338-353

RAE-Real Academia Española. (2023). Dictionary of the Spanish language (Spanish). Available online: https://dle.rae.es (accessed on 30 January 2023).

Rips, L. J., Shoben, E. J., & Smith, E. E. (1973). Semantic distance and the verification of semantic relations. Journal of verbal learning and verbal behavior, 12(1), 1–20. https://doi.org/10.1016/S0022-5371(73)80056-8

Roll-Hansen, N. (2017). A Historical Perspective on the Distinction Between Basic and Applied Science. Journal for General Philosophy of Science, 48(4), 535–551. https://doi.org/10.1007/s10838-017-9362-3

Shull, J. M., & Saken, J. M. (1995). Noncoeval star formation, starbursts, and the growth of supershells in OB associations. The Astrophysical Journal, 444, 663. https://doi.org/10.1086/175638

Simonton, D. K. (2009). Varieties of (Scientific) Creativity: A Hierarchical Model of Domain-Specific Disposition, Development, and Achievement. Perspectives on Psychological Science, 4(5), 441–452. https://doi.org/10.1111/j.1745-6924.2009.01152.x

Strohecker, C. (2018). Reshaping the Discourse about Higher Education. Leonardo, 52, 2–2. https://doi.org/10.1162/LEON_A_01695

Terniievska, Y. (2022). Process of conceptualization as an aspect of human cognitive activity. Advanced Linguistics. https://doi.org/10.20535/2617-5339.2022.9.258879

United Nations Educational, Scientific and Cultural Organization [UNESCO]. (1979). Report of the Director-General on the activities of the organization 1977–1978. Paris: UNESCO.

Valdez, M. J. L. (2002). Natural semantic networks, uses and applications in social psychology. Universidad Autónoma del estado de México.

Walach, H. (2020). Inner Experience—Direct Access to Reality: A Complementarist Ontology and Dual Aspect Monism Support a Broader Epistemology. Frontiers in Psychology, 11. https://doi.org/10.3389/fpsyg.2020.00640