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Visualization of information and knowledge to communicate social sciences research results

Visualización de información y conocimiento para comunicar resultados de investigación de las ciencias sociales

Visualização de informação e conhecimento para comunicar resultados de investigação das ciências sociais

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ABSTRACT
The visualization of information and knowledge enables an understanding of the hidden meaning of the information that is not directly apprehensible from the data, processes and phenomena, facilitating the obtaining and communication of relevant research results. However, the application of its methods and techniques in the training of social science professionals is still insufficient, which has limited their research performance. The objective of the article was to base a theoretical model of the dynamics of training in information and knowledge visualization for the communication of research results in the social sciences. The research methods used were content analysis of relevant theoretical sources and systemic modeling with a holistic-configurational approach. The main result of the modeling is to have revealed as a regularity the dialectical relationship that is expressed between the selection of information and scientific knowledge to communicate and the systematization of its optimal visualization. It is concluded that this regularity is a necessary and essential condition for the development of the visualization of information and knowledge competence for the communication of research results in the social sciences.

Keywords: social sciences; communication of research results; dynamics; training; information and knowledge visualization.

RESUMEN
La visualización de información y conocimiento posibilita una comprensión del sentido oculto de la información, que no es directamente aprehensible desde los datos, procesos y fenómenos, facilitando la obtención y comunicación de resultados de

investigación relevantes. Sin embargo, todavía es insuficiente la aplicación de sus métodos y técnicas en la formación de los profesionales de las ciencias sociales, lo que ha limitado su desempeño investigador. El objetivo del artículo fue fundamentar un modelo teórico de la dinámica de formación en visualización de información y conocimiento para la comunicación de resultados de investigación de las ciencias sociales. Los métodos de investigación empleados fueron el análisis de contenido de fuentes teóricas relevantes y la modelación sistémica con un enfoque holístico-configuracional. El resultado principal de la modelación es la regularidad que emerge de la relación dialéctica que se expresa entre la selección de la información y conocimiento científico a comunicar y la sistematización de su visualización óptima. Se concluye que esta regularidad es una condición necesaria y esencial para el desarrollo de la competencia visualización de información y conocimiento para la comunicación de resultados de investigación de las ciencias sociales.

Palabras clave: ciencias sociales; comunicación de resultados de investigación; dinámica; formación; visualización de información y conocimiento.

RESUMO
A visualização de informação e conhecimento possibilita uma compreensão do sentido oculto da informação que não é diretamente apreensível dos dados, processos e fenômenos, facilitando a obtenção e comunicação de resultados de investigação relevantes. Entretanto, ainda é insuficiente a aplicação de seus métodos e técnicas na formação dos profissionais das ciências sociais, o que limitou seu desempenho investigador. O objetivo do artigo foi fundamentar de um modelo teórico da dinâmica de formação em visualização de informação e conhecimento para a comunicação de resultados de investigação das ciências sociais. Os métodos de investigação empregados foram a análise de conteúdo de fontes teóricas relevantes e o modelado sistêmico com um enfoque holístico-configuracional. O resultado principal do modelado é haver revelado como regularidade a relação dialética que se expressa entre a seleção da informação e conhecimento científico a comunicar e a sistematização de sua visualização ótima. Conclui-se que esta regularidade é uma condição necessária e essencial para o desenvolvimento da competência visualização de informação e conhecimento para a comunicação de resultados de investigação das ciências sociais.

Palavras chave: ciências sociais; comunicação de resultados de investigação; dinâmica; formação; visualização de informação e conhecimento.

INTRODUCTION

The role played by the social sciences in the investigation of the processes that take place within society is of unquestionable importance, supported by numerous scientific methods that allow it to delve into relevant events that occur frequently, to extract regularities that support the establishment of foundations that anticipate explanations about the society of the future (Mayet, Alonso, Gorina&Martin, 2022).

In this way, to achieve significant results and make transcendental contributions to the solution of the problems that affect society, the social reality plagued by uncertainty and subjectivity must be scientifically examined, which requires the use of efficient research methods that lead to obtaining objective, rigorous and precise results (Demerath, Reid

& Suarez, 2020; Harrison, Reilly & Creswell, 2020).

In social research, the use of the informational approach is increasingly frequent, which promotes a new research dynamic, characterized by the conversion of data into information and of this into potentially transforming knowledge of social reality (Gorina & Alonso, 2016). The application of this approach constitutes an essential condition to achieve a coherent relationship between the level of scientific activity with social needs and demands.

In this direction, it is important to recognize the essential role that communication has as part of the scientific research process, which constitutes a link between the individual and society and allows us to identify the essentially communicational nature of all social phenomena, which indisputably involves the individual and society in all its complexity, through the reception, understanding and application of information (Martín, Gorina, Alonso &Ferrer, 2021).

In the particular case of the communication of research results, scientists are called to consider, in addition to disseminating information and knowledge, the transmission of the data they collect and the models they design to facilitate their access, so that they are useful to other specialists for its subsequent application and improvement (Cuschieri, Grech & Savona, 2019).

Consequently, the current development of science requires the presentation, distribution and reception of research results to society through channels (formal and informal), all of which should make it easier for researchers from various areas of knowledge to share their contributions. (Martin *et al.,* 2021).

For this, different visualizations can be used to communicate scientific results, by using, jointly, the communication qualities of the image and verbal language, aimed at developing different strategies to achieve effective communication (Mayet, Alonso & Gorina, 2021; Gorina, Alonso & Salgado, 2017; Ware, 2004).

However, from the perspective of information and knowledge visualization, when it comes to solving complex problems, not enough methods and techniques have yet been incorporated into the training of researchers in social sciences, which has limited their performance to achieve visualizations that allow adequately representing the results of the investigations that are carried out (Mayet et *al.,* 2021, 2022).

Researches close to the subject have made proposals to manage the training of researchers focused on the processing of social information (Gorina & Alonso, 2013) and on the management of this information (Gorina &Alonso, 2017), but none has achieved a comprehensive proposal that facilitates said training from a system that processes, manages and communicates it to obtain relevant results, that favor creative research activity and allow perfecting the process of visualizing information and knowledge, oriented towards the communication of scientific results of the social sciences.

For this reason, the training of professionals in the social sciences requires the development of visualization resources, seen as methods of reasoning and research for the communication of their research results; that allow you to visually represent information, data or knowledge, as a way not only to effectively explain complex concepts and the relationship between them, but also to discover new knowledge and achieve efficient communication of results obtained in their research (Gorina, Alonso & Salgado, 2017).

For this reason, the objective of this study was to support a theoretical model of the dynamics of training in information and knowledge visualization for the communication of research results in the social sciences. This training is designed to be carried out through the postgraduate course that every professional in any of the social sciences must receive as a completion and updating of their scientific training.

This objective is of great importance, since from this model the trainers of researchers in the social sciences could better understand the foundations, threads and relationships that support the aforementioned dynamic, aimed at enhancing performance in the communication of research results.

MATERIALS AND METHODS

Content analysis of relevant theoretical sources was used to determine the theoretical - methodological bases of the dynamics of training in information and knowledge visualization for the communication of research results in the social sciences.

In addition, the study was based on the Holistic-Configurational Theory (Fuentes, Álvarez & Matos, 2004), which offers a system of categories made up of configurations, dimensions and links, which facilitates the explanation of the dynamic, systemic and complex nature of the theoretical model provided. This theory was ideal to reveal the system of essential relationships and the regularity of the aforementioned model, given its systemic, dialectical and totalizing character.

For the modeling, the results provided by Ware (2004) were taken into account, which presuppose that the visualization process must go through an adequate data collection, the application of techniques for its transformation and the availability of understandable specifications as a basis for a manageable visual representation.; In addition to allowing explorations in the data to take advantage of the natural cognitive processing, through the interaction with the elaborated images, which makes it possible to obtain new perspectives of the phenomenon or process investigated.

In turn, to do the modulation Gestalt laws or principles were taken into account (Gorina, Alonso & Salgado, 2017), which explain how the human mind configures various elements that reach it through sensory channels (perception) or memory (thought, intelligence and problem solving).

The risks or inconveniences of visualization of a cognitive, social and emotional nature were also taken into account (Gorina, Alonso & Salgado, 2017), which are an essential part of the modeling training process.

Finally, for greater precision, it was necessary to explain how a competition is conceived. For this, the perspective of researchers B. Castellanos, MJ Llivina and AM Fernández was assumed, who defined competence as:

> A psychological configuration that integrates various cognitive, metacognitive, motivational components and personality qualities, in close functional unity, self-regulating real and efficient performance in a specific sphere of activity, in correspondence with the desirable performance model, socially constructed in a specific historical context (cited by Martín, Gorina, Alonso & Ferrer, 2020, p. 252).

RESULTS

Modeling of training dynamics in information and knowledge visualization for the communication of social science research results

This dynamic is interpreted as those relationships that are established within the training process, which facilitate the consolidation and forecasting of its evolution, from an integrating logic of the contents of information and knowledge visualization, which serves as the basis for the conception of a system of didactic procedures to guide it, favor the communication of science and contribute to the formation of the visualization of information and knowledge competence for the communication of research results in the social sciences.

The proposed model is made up of three dimensions, which represent its internal movements and allow explaining the transformation of the training dynamics into information and knowledge visualization for the communication of social science research results. These dimensions are: identification of the scientific communication problem, optimization of the visualization of information and knowledge to be communicated, and effectiveness of the communication of research results (see figure 1).

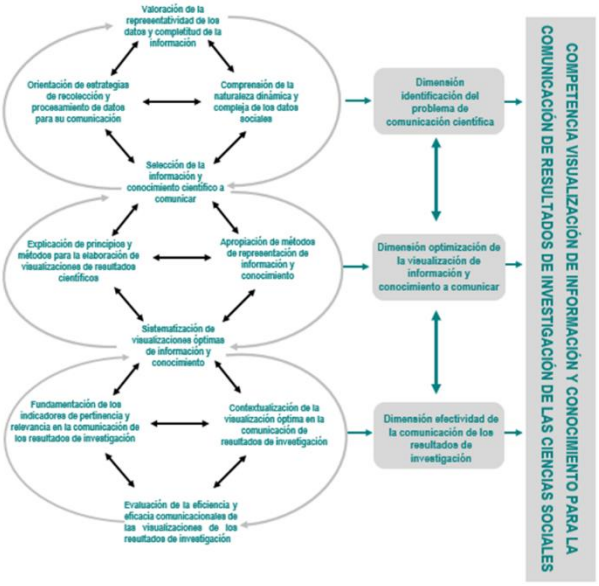

Fig. 1- Model of the dynamics of training in visualization of information and knowledge for the communication of research results in the social sciences

Scientific communication problem identification dimension

This dimension of the process reveals the relationship between the orientation of data collection and processing strategies for their communication and the understanding of the dynamic and complex nature of social data; this is synthesized, in the first instance, in an assessment of the representativeness of the data and completeness of the information and, in the second instance, in the selection of the information and scientific knowledge to be communicated (see figure 1).

These configurations are an expression of their movement, based on the essential relationships that occur between them as dialectical processes that associate the hermeneutical and the complex of the formation process that is modeled.

The configuration *orientation of data collection and processing strategies for communication* is expression of that process carried out by the postgraduate professor to provide students with methods, techniques and procedures for obtaining data, as well as how to prepare said data for holistic and synergistic processing, in correspondence with the objectives of the research.

For this, an orientation must be carried out that emphasizes the importance of an adequate selection of information sources, specifying the ways to locate them and the limitations of the information collected in order to obtain accurate data.

Likewise, it must ensure that the postgraduate student participates collaboratively in the construction of their knowledge, understands the importance of using qualitative and quantitative methods to be able to interpret a social, dynamic and complex reality that requires the availability of pertinent data. It will also promote mastery of techniques and procedures that facilitate the collection and processing of said data during the investigation process and the need to make adequate use of the different sources of information.

In particular, it will be necessary to contribute to the development of skills for data processing, based on filtering techniques, computer programs, the establishment of statistical parameters, their interpretation and visualization; so that, through its correct processing, it can convert them into scientific information.

However, this orientation of data collection and processing strategies for communication, carried out by the professor, favors the graduate student to achieve an *understanding of the dynamic and complex nature of social data* ; configuration that is interpreted as the process of discernment carried out by the postgraduate student to relate and structurally and functionally integrate social data, in order to capture the dynamic, systemic and complex nature of the social reality that he investigates, based on the information contained in said data and aimed at making informed decisions.

From this configuration, the development of skills in the postgraduate student will be promoted, to analyze the social phenomena that allow them to specify the veracity of the properties, relationships and social behaviors investigated, as well as the validity of the managed information that reflects it. This aspect will enable a relevant reconstruction of meanings and findings that emerge from the study of the social reality in which this student intervenes.

This process of understanding the social nature of managed data should lead the postgraduate student to a continuous interpretation and construction of knowledge from the research context itself, by allowing a rational and systemic approach to the validity of the information used to support the process of scientific research of social phenomena.

Consequently, they must appropriate and apply methods, techniques and procedures for the processing of social data, which allow an adequate interpretation of their object of study. For this, it will critically evaluate the potential of the information contained in the data, through a contextualized hermeneutic experience, in which it will put into practice its interpretation resources to reconstruct the relevant relationships of the social and make well-founded decisions, associated with its research process.

Now, a dialectical relationship is established between the explained configurations, based on the recognition that to the extent that the teacher guides the way of using these strategies, the understanding of the dynamic, systemic nature is facilitated in the

postgraduate student. and complex of the social process that investigates; In turn, through this understanding, the relevance of the orientation carried out and its correspondence or not with the demands of the training process are verified, giving rise to a greater knowledge of this and of the methods, techniques and procedures necessary to unveil the qualitative essence of the investigated social reality.

The contradiction is manifested because a change in the orientation of the strategies implies a possible modification of the way in which the student understands the complex and dynamic nature of the social information that is managed, which provides new knowledge to carry out social research; these knowledges that, when learned, make it possible to establish new criteria to develop them. Meanwhile, a significant deepening in the dynamic and complex nature of the social process under investigation can enrich the orientation of strategies, perfecting the one that had been initially oriented by the teacher, due to its limitations in terms of its completeness and relevance.

The relationship between these two configurations is synthesized in the *assessment of the representativeness of the data and the completeness of the information*, which is interpreted as a synthesis configuration, carried out by the professor and the postgraduate student, which expresses the capacity of the latter to evaluate if the data that have been obtained reflect the main features and qualities of the social phenomenon under study, based on the application of technical criteria that guarantee correspondence and completeness of the data and its underlying information, with the features and qualities of the aforementioned phenomenon.

Among the technical criteria, the following stand out: the adequate selection of the sample (size and selection mechanism), the type of research to be carried out and its coherence with the methods, techniques and procedures applied for data management and processing, the criteria of validity and reliability used, the identification of the type of science communication problem that is intended to be solved.

The achievement of relevant assessments will depend on the emphasis that the teacher puts on carrying out activities that contribute to the development of skills to compare the data obtained and abstract, generalize and synthesize significant information from them, which allows making value judgments about the social reality investigated.

Finally, the student will have to analyze the existing relationships between the data selected as relevant and abstract from the specific context, from the application of the oriented strategies, in order to discover new and significant information, using the existing data; process that will favor the effective transformation of data into relevant information.

The explained relationship is also synthesized in the *selection of information and scientific knowledge to communicate,* which is interpreted as a synthesis configuration, carried out by the professor and postgraduate student, which expresses the ability of the latter to organize and synthesize relevant social information, in order to facilitate its understanding and transformation into scientific knowledge and its communication to different interested groups.

At this point, it will be necessary to make the student understand that this selection corresponds to the application of a set of criteria that make it possible to identify analytical categories, variables and relationships between them, based on the processing of information extracted from the social reality that is investigated.

In the development of this process, the selection of scientific information and knowledge that is intended to be communicated is key; For this, it is essential to know the scientific information needs of user groups, as well as their cultural and contextual characteristics, which will make it possible to establish effective scientific communication with them.

The relations between the four explained configurations allow to explain the *identification dimension of the scientific communication problem* , interpreted as the movement that is established between the orientation of data collection and processing strategies for its communication and the understanding of the dynamic and complex nature of the social data, which is synthesized in an assessment of the representativeness of the data and completeness of the information and in the selection of the information and scientific knowledge to be communicated; which expresses a first stage of development of the dynamics of training in visualization of information and knowledge for the communication of research results in the social sciences.

This identification refers to the ability that the student must develop to recognize the type of scientific communication problem to be solved, based on the selection of the information and knowledge that it intends to communicate and knowing the scientific information needs of the user groups.

Optimization dimension of the visualization of information and knowledge to be communicated

In turn, the synthesis configuration, selection of information and scientific knowledge to communicate, generates another movement of the process, which through the optimization dimension of the visualization of information and knowledge to communicate expresses the relationship that is established between the explanation of principles and methods for the elaboration of visualizations of scientific results and the appropriation of methods of representation of information and knowledge.

In this way, the configuration *explanation of principles and methods for the elaboration of visualizations of scientific results* is interpreted as the process of teaching the principles and methods that the researcher needs to conceive visualizations of information and knowledge inherent to their research results, emphasizing in the representation of different dimensions and parameters that need to be communicated.

To achieve this, the teacher will explain the fundamental principles that facilitate the conception of visualizations: direction, proximity, closure, relationship between figure and background, similarity or similarity, pregnancy or simplicity, past experience or custom, preparation or expectation and grouping based on a cause-effect relationship. Likewise, it will expose visualization methods for the treatment of information, such as mathematical (numerical, statistical, optimization, geometric, etc.), computer, text mining, content analysis, etc.

In turn, they will need to develop skills to select the most convenient types of visualizations to communicate information and knowledge associated with their scientific results, whether to present a paper, an article, an infographic, a thesis report, etc.

It so facilitates a set of connectionist, network and dimension reduction techniques that enable an adequate design, management and preparation of the information to be represented through different types of visualizations. At this point, it will be important to warn about possible

risks of representation, such as ambiguity, breaking conventions, encrypted coding, hiding, inconsistency, low precision, excessive determinism, excessive complexity or simplification, redundancy, misuse of color, etc.

However, the explanation of principles and methods for the elaboration of visualizations of scientific results, carried out by the teacher, is not a sufficient condition for the student to establish an effective communication of scientific results. That is why this process will be developed in close relationship with the *appropriation of information and knowledge representation methods,* which is conceived as the configuration that accounts for the learning process of the development of optimal displays of information and knowledge, for part of the postgraduate student, in order to communicate, to user groups, different dimensions and parameters associated with their research results, to meet the needs of scientific information.

In this way, the student must develop skills to select and elaborate different types of visualizations such as: diagrams, maps, data tables, graphs, infographics, cognitive models and oral and written texts, among others, that allow them to efficiently represent and effective, the dynamic, systemic and complex nature of the social reality investigated.

It will also be important for them to use computer systems to make different types of visualizations, which help to represent information, while amplifying, reinforcing or increasing their cognition about different phenomena or social processes. For this, it will be pertinent to be motivated by the use of visualizations that represent different dimensions and parameters of scientific information, in such a way that reflection on their usefulness is promoted, in relation to the different channels available to establish the communication of scientific information.

Now, a dialectical relationship is established between the two previous configurations, since, to the extent that the professor explains the methods to be used to elaborate the visualizations of the scientific results, the postgraduate students will appropriate them through their application, which will help to verify the adequacy of the elaborated visualization and, consequently, the effectiveness of the explanation made by the teacher; evidencing a correct appropriation of the methods of representation of information and knowledge.

The contradiction is manifested because a change in the explanation of the aforementioned methods leads to a possible modification in their appropriation, since it introduces new elements of analysis, which, when taken care of, facilitate the conception of new visualizations; while a deeper study of the possible representations of information and knowledge, using the revealed methods, can enrich the explanation initially made, requiring a greater depth.

In this way, the previously explained dialectical relationship is also synthesized in the *systematization of optimal displays of information and knowledge* , which is considered as a synthesis configuration, carried out by the professor and postgraduate student, which expresses the sequential and cumulative process of significant knowledge about the principles, methods and techniques, which can be used to achieve optimal visualizations that allow representing the dynamic, systemic and complex nature of the social reality investigated, based on the information and knowledge generated in the Social research process.

To be successful in the aforementioned systematization, it will be necessary to carry out activities in which the student develops visualizations that increase in the level of complexity of the information and knowledge representation methods to be used, but keeping in mind the risks of representation at all times.

In this systematization, the teacher and the student must keep in mind a double perspective. The one that is directed, on the one hand, towards the appropriation of principles, methods and techniques that can be used to achieve optimal visualizations and, on the other, the one that is oriented to satisfy the requirements of the science communication process.

In this way, the systematization of optimal visualizations that is carried out serves as monitoring in the modeled dynamics, becoming a process that allows the self-control of the postgraduate student on his abilities to visualize information and knowledge, in relation to the communication of scientific results.

Consequently, a new movement of the training dynamics in information and knowledge visualization for the communication of research results of the social sciences originates, from the relationships established between the four explained configurations, which becomes a second level of essentiality, which is given by the optimization dimension *of the visualization of information and knowledge to be communicated*, conceived as an expression of the teaching-learning process ; This enables the appropriation of the principles and methods for the development of optimal visualizations, which help to efficiently communicate scientific results by minimizing the risks of representing information and knowledge, in correspondence with a group of users.

Therefore, this optimization process implies the need to develop skills to visualize information and knowledge in a simple, accessible and sensory way, in a way that favors agile decision-making, based on clear objectives; select appropriate visualizations, with a use of colors that facilitate understanding and perception, the careful choice of data, as well as the integration of data visualization technologies, which allow key information to be displayed through graphs, tables, maps, etc. , and draw conclusions from them to make the best decisions in real time.

In summary, the postgraduate student must learn to create visualizations, based on the demands for scientific information, making them allow them to communicate their research results in an optimal way.

Effectiveness dimension of communication of research results

The synthesis configuration, systematization of optimal displays of information and knowledge, gives rise to another movement of the process, which through the effectiveness dimension of the communication of research results expresses the relationship established between the foundation of the indicators of relevance and relevance in the communication of research results and the contextualization of optimal visualization in the communication of this type of results.

Therefore, the *foundational configuration of the pertinence and relevance indicators in the communication of research results* is interpreted as the explanation process carried out by the postgraduate professor on the main pertinence and relevance indicators that must be considered to achieve an optimal visualization of information and knowledge, which allows effective communication of scientific results to different groups of users.

For such purposes, it will critically expose the elements of interest in relation to the relevance of a scientific community and its contribution to innovation, the quality and scope of scientific activity, its social relevance in the regional, national and international context, as well as the ability of researchers to build synergies and socialize the knowledge generated.

It will present science and technology indicators, as social constructs that serve to measure actions related to the generation, transmission and application of scientific and technological knowledge. It will emphasize the components of scientific and technological activities: Research, Development and innovation (R+D+i), scientific and technical education and training, scientific services, as well as the importance of the adequate use of financial and human resources to execute projects of research and development.

In addition, it will propose activities that guarantee the use of techniques and procedures from the metric disciplines of information, mainly bibliometric, altmetric and scientometric studies, which allow analyzing the relevance or bibliographic relevance of scientific results, as well as assessing their productivity and scientific usefulness.

Thus, the teacher will promote the understanding that the impact of the social sciences must also be measured in terms of social relevance, and it is necessary to apply strategies to increase this impact. The teacher will encourage reflection on the communication process in these sciences, questioning the traditional models that excessively weigh the scientific and economic impact, to the detriment of the social one, which should be oriented towards innovations that have repercussions on the progress of society.

However, the justification of the pertinence and relevance indicators in the communication of research results carried out by the teacher, by itself is not enough for the student to achieve effectiveness in this type of communication, so it should be carried out in close relation to the *contextualization of optimal visualization in the communication of research results* , as a configuration that expresses the process carried out by the postgraduate student to understand and use the set of circumstances (material or abstract) that surround him, in space and time, and that will allow you to communicate your research results, based on the optimal visualization elaborated, considering the indicators of pertinence and relevance.

The student will understand that science is a social process and that the actions and behaviors of scientists are closely related to the context. In addition, you will perceive that the pertinence and relevance indicators represent an aggregate and complex measurement of the research results, which allows describing or evaluating a social phenomenon, its nature, state and evolution.

In addition, you will learn to **socialize your research results with the scientific community, through** presentations at conferences or scientific meetings and the publication of articles, books or research reports. For its elaboration, it will use the main indicators and quality criteria that these require for its structuring and writing. All this so that interested researchers can make use of them and replicate experiments and research experiences, thereby facilitating the enrichment of scientific knowledge.

It will also recognize the importance of information and communication technologies to give optimum visibility and accessibility to its scientific results. For which it will be fundamentally based on the principles and initiatives of open science, in order to provide

accessibility to scientific research for all citizens.

Now, between the two configurations explained, a dialectical relationship is established, since, to the extent that the teacher bases the indicators of pertinence and relevance of the communication of research results, the student manages to contextualize various optimal visualizations that it has systematized, which helps to verify the validity of these indicators, in correspondence with the requirements and protocols required for the aforementioned communication in the different existing channels.

The contradiction is expressed because the deepening of the foundation of the pertinence and relevance indicators in the communication of the research results, in relation to the demands of the user groups, leads to a reconceptualization of the ways used to contextualize the optimal visualizations that have been systematized , which favors the development of superior visualizations that adjust to the new communicational demands of the context; while a deepening in the visualizations, product of a greater knowledge of the contextual elements that are needed to establish an effective communication, requires that the foundation of the pertinence and relevance indicators be deepened, which could contradict those initially assumed.

As a result of the dialectical relationship that is established between these configurations, the *evaluation of the communicational efficiency and effectiveness of the visualizations of the research results emerges* , as a synthesis configuration that is an expression of the evaluation and measurement process carried out by the postgraduate student to check the communicational efficiency and effectiveness of the visualizations of their research results, based on the pertinence and relevance indicators that they have considered.

To achieve this, it must analyze the main criticisms that the visualizations of its results have received, as well as the questioning of the use of the indicators considered and the debates that have been generated around the quality, pertinence and social relevance of its results. You must understand that the evaluations you make will take into account the conceptual, economic and historical context of the society where they act, since the visualizations of your research results must be seen and interpreted within the social context in which they are framed, measuring these results in relation to the expectations of society.

In this way, the indicators of pertinence and relevance that are implemented for this evaluation, must contemplate the greatest number of elements that allow a multidimensional analysis of the processes that are revealed in them, from a holistic perspective and a markedly social approach, understanding the epistemological nature that supports it, appreciating its main advantages and potentialities to efficiently and effectively communicate research results, capturing their strengths and weaknesses and facilitating their dissemination through appropriate information channels.

In summary, the movement that emerges as a result of the dialectical relationship that is established between the four configurations explained gives rise to the *effectiveness dimension of the communication of research results,* which reflects the ability to achieve the objectives of said communication through optimal visualizations, which are obtained from the relevant information and knowledge obtained in the research activity, in order to propose solutions to various social problems; all of which allows to reinforce the

communicational function from the visualization.

In this way, the researcher reaches measurable results with a significant level of completion, based on the proper use of available material and human resources, as well as the correct application of scientific methods, techniques and procedures, which allow reaching their research objectives and solve the identified problem in a novel way.

Now, from the relationships that occur in the three dimensions of the model emerges the *visualization of information and knowledge competence for the communication of research results in the social sciences*, conceived as a synthesis of knowledge, skills and transcendental values for the university professor , so that it can identify scientific communication problems, manage information and relevant knowledge about them and make optimal visualizations that enhance the effectiveness in the communication of research results, demonstrating suitability, ethical commitment and social responsibility and integrating and developing their knowledge, modes of action and system of professional values.

Consequently, by developing this competence, the professional social sciences will achieve an efficient performance for the design of information and knowledge visualizations, converting the complex social phenomena of the reality that they investigate into attractive, interesting, understandable, logical and intuitive visual messages. These messages favor the process of communicating the results of scientific activity, which must satisfy the demands of the socio-communicative context, through efficient and pertinent knowledge and management of linguistic, textual, hermeneutical, pragmatic, informatic, technological and sociocultural resources.

In short, with the formation of the visualization of information and knowledge competence for the communication of research results in the social sciences, the aim is to form values in researchers in the spheres: intellectual, aesthetic, ethical and ideological.

DISCUSSION

The modeling of the dynamics of training in visualization of information and knowledge for the communication of research results in the social sciences, gives rise to a *system of essential relationships* that allows interpreting their behavior and transformation. This system is made up of the following relationships:

- The selection of information and scientific knowledge to communicate, based on an orientation of social data collection and processing strategies and an understanding of the dynamic and complex nature of these data, is based on an assessment of its representativeness and informational completeness and facilitates the identification of the scientific communication problem to be solved.
- The explanation and appropriation of principles and methods for the elaboration of visualizations of scientific results enhances their systematization, giving rise to a movement that generates an optimization of the visualization of information and knowledge to be communicated.
- The effectiveness in the communication of the research results, evaluated from the communicational efficiency and effectiveness of the visualizations of said results, is carried out through pertinence and relevance indicators

that facilitate the contextualization of the optimal visualizations of said results.

From the deepening of the study of these relationships, the integrative logic that is established between the selection of information and scientific knowledge to communicate and the systematization of optimal visualizations of information and knowledge is revealed as a regularity, which is constituted in an essential necessary condition in the formation and development of the visualization of information and knowledge competence for the communication of research results in the social sciences.

It is necessary to specify that the model proposed in this article is part of the informational approach to science (Gorina & Alonso, 2016, 2017) and that, therefore, it constitutes a new theoretical contribution aimed at improving training of researchers in the social sciences processes.

Now, despite the development experienced at the international level in Information and Communication Technologies, it is recognized that the field of information and knowledge visualization has had a limited application in the social sciences (Gorina, Alonso &Salgado, 2017 Meyer & Dykes, 2018; Fadiran, Biljon, and Schoeman, 2020; Van Biljon&Osei-Bryson, 2020).

Despite this limited application, two pedagogical models were found in the specialized literature that have been contributed from the informational approach to science and are closely related to the proposed model. One of them is the "Model of the formative dynamics of information processing in social research" (Gorina & Alonso, 2013), which reveals the integrative logic that is established between the understanding of the validity and reliability of social information and the systematization of its synthesis and concretion, consistent with its qualitative and quantitative processing.

This model cited bases the process of training researchers focused on the processing of social information, without taking into account other processes associated with the communication of research results, so it is not capable of reflecting a totalizing nature of the process of managing social information.

However, the model proposed in this article manages to explain in greater depth the relationship that is expressed in the dynamics of formation between the processing of social information and its communication centered on the visualization of information and knowledge (see figure 1); essential relationship in achieving the formation and development of the visualization of information and knowledge competence for the communication of research results in the social sciences.

The other model located in the specialized literature is the "Theoretical model of the management of the life cycle of the information of the pedagogical investigations" (Gorina and Alonso, 2017). It was designed with the purpose of improving the training of researchers in the pedagogical sciences in information management, by representing research as a complex informational system that manages, transmits and processes information to extract one with new qualities, which favors the activity authentically creative.

Although this model focuses on pedagogical information, it can help to understand how researchers represent the information management process in social research, from a systemic and comprehensive perspective. However, this model does not delve into the relationship established between the selection of scientific information and knowledge to be

communicated and the systematization of its optimal visualizations (see figure 1). Another limitation that it presents is that it does not fully penetrate the dimension of training, by not explaining how the modeling process contributes to the formation of research skills.

The aforementioned aspects are the basis for considering that the proposed model is novel, since it manages to establish new relationships that had not been based on the scientific literature consulted. At the same time, it is considered that this proposal is pertinent, since it is conceived in order to improve the process of visualizing information and knowledge oriented to the communication of research results in the social sciences, a process in which currently a significant number of researchers present insufficiencies (Gorina, Alonso &Salgado, 2017; Meyer & Dykes, 2018; Mayet, *et al.,* 2021, 2022).

Despite having argued qualities of the proposed model, it is appreciated that its possible limitation lies in the fact that it has not yet been empirically contrasted. However, it is appropriate to remember that there is a tradition when building scientific knowledge in the empirical sciences, which consists of accepting theoretical proposals that present a plausible foundation and that, subsequently, empirical evidence is sought to assess its level of correspondence with the explanation and prediction of the facts of the reality under study.

Consequently, readers interested in the topic discussed in this article are encouraged to design practical instruments that make it possible to specify the different qualities of the proposed model, in order to improve the performance of social science researchers.

Based on the elements exposed above, it is concluded that the proposed model is novel, pertinent and current, and that its regularity expresses the relationship between the selection of information and scientific knowledge to be communicated and the systematization of its optimal visualization, which it is a necessary and essential condition in the formation and development of the visualization of information and knowledge competence for the communication of research results in the social sciences.

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Authors declare not to have any conflicts of interest.

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