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The V Heuristic In Scientific Inquiry: A Systematic Review

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Abstract

Research represents the possibility of having a country in progress. If research is done in school classrooms, the research culture achieved is unquestionable, thus generating scientific entities that bet on the development of a nation. For this purpose, strategies are needed to facilitate the structure of inquiry development in the classroom, because there are difficulties in this regard, due to the lack of knowledge of methodological strategies that facilitate the organization of what is being investigated. From this analysis, the need-to-know Gowin's V heuristic arises. The objective of this research was to analyze the scientific contributions to the scheme of the V heuristic in scientific inquiry. For this purpose, indexed journals selected between the last five years, 2017 to 2021, and according to the guidelines of the PRISMA statement were consulted. Finding: 300 research articles in Google Scholar, 72 in Redalyc, 34 in Ebsco, 8 in Pro Quest, and 1 in Scielo. Of the total, 50 articles were selected for review, including the 14 relevant articles, which allow the analysis of the structure, the questions considered for their development, and the most outstanding contributions in educational matters obtained, such as significant learning from inquiry, since it includes in its scheme previous knowledge to be associated to new concepts; problem-solving and the search for topics that arise from observation.

Keywords: V heuristics; Strategy; Meaningful learning; Problem-solving; Methodology.

Resumen

La posibilidad de tener un país en progreso, es la investigación. Si se hace investigación en las aulas escolares, es indudable la cultura investigativa lograda, de esta manera se generan entes de ciencia que apuestan por el desarrollo de una nación. Para el fin, se necesitan estrategias que faciliten la estructura del desarrollo indagativo en aula, porque se tienen dificultades a ese respecto, por el desconocimiento de estrategias metodológicas que faciliten la organización de lo que se está investigando. De este análisis, surge la necesidad de conocer la V heurística de Gowin. La presente investigación tuvo como objetivo; analizar los aportes científicos sobre el esquema de la V Heurística en la indagación científica. Para este propósito, se consultó revistas indexadas seleccionadas entre los últimos cinco años, 2017 al 2021 y de acuerdo a las orientaciones de la declaración PRISMA. Hallándose: 300 artículos de investigación en Google Académico, 72 en Redalyc, 34 en Ebsco, 8 en Pro Quest y 1 en Scielo. Seleccionándose del total 50 artículos para su revisión, incluidos los 14 artículos relevantes, que permiten el análisis de la estructura, las preguntas consideradas para su desarrollo y los aportes más resaltantes en materia educativa obtenidas, como el aprendizaje significativo desde la indagación, ya que incluye en su

esquema conocimientos previos para ser asociados a nuevos conceptos; la resolución de problemas y la búsqueda de temas que nacen de la observación.

Palabras Clave
V heurística; Estrategia, Aprendizaje significativo; Resolución de problemas; Metodología.

Introduction

The teaching and learning of students in this time of confinement, according to the Ministry of Education (MINEDU) (2020), is the responsibility of the teacher, who must work under the modality of projects and contextualized activities, adapting situations and proposing solutions according to student and community needs, from their observation and experience, generating researchers that allow betting on the progress of the country (MINEDU, 2016). This purpose is not achieved by not having methodological strategies that allow the construction of inquiry, integrating the student's previous knowledge, to be complemented with the concepts that the teacher gives him/her to build a new concept. In this eagerness to form scientific entities from the classroom, the need arises to investigate Gowin's V, also called heuristic or epistemological V, which is a systematization of concepts to inquire, in a creative, individual, and group modality. Therefore, in the present research, information was analyzed, guided by the question "How does the V Heuristic allow scientific inquiry? To answer this question, databases were consulted, to analyze the scientific contributions of the V Heuristic scheme in scientific inquiry.

Gowin calls the V diagram a heuristic technique to understand and produce knowledge (Novak & Gowin, 1988). According to Padilla & Paredes (2019), this strategy is a guide in the understanding of knowledge. The author, raised a didactic element, a strategy that will be the teaching support for the understanding of certain subjects, as well as problem-solving.

Gowin's Uve is then a heuristic resource that supports the subject to understand the structure and each constructive process of knowledge. In it, the student tests all his conceptual resources, which he complements with the analysis, interpretation, synthesis, and evaluation of the knowledge or significant learning to be constructed. Guerrero (2019) and Rodríguez (2008) quote Ausubel (1973,1976,2002) in which he mentions the psychological theory of classrooms; in each learning process, the student puts into play his abilities, knowledge, capacities, skills, and creativity for each situation to be known; while meaningful learning, guarantees the acquisition, retention, and assimilation of concepts highlighted in the learning sessions and problem-solving.

Existing knowledge, when related to new information, should not be considered as a sum of knowledge or concepts, but as a close link that generates new but significant learning. Martin (2018) argues that learning and changes in educational institutions occur by developing strategies for educational improvements.

The heuristic V diagram, then, provides scaffolding in the construction of learning, makes thinking explicit, and generates a visual aid of who constructs the Uve. The idea of scaffolding is framed in the socio-constructivist perspective (Vygotsky, 1979), which considers that learning takes place in a plane of social interactions. The person with more knowledge guides the learning of the other, therefore in the construction of the diagram, more than one can intervene, integrating knowledge to provide solutions to problems in their environment. Therefore, it is important to consider the structure of the curriculum and its execution, as well as the means, and elements, together with the feelings and the implementation, which are part of any meaningful learning experience (Guardián and Ballester, 2011).

As Gowin's V is a heuristic technique, the importance of the knowledge of the term Heuristic(a) is born, which according to the RAE (2014) in its fourth meaning, indicates that, the word heuristic, from gr. εὑρίσκειν heurískein 'to find', 'to invent. It is a way of

searching for or giving a solution to a problem using flexible methods. Likewise, significados.com (2021) states that heuristics is held as an art of imagining, discovering, and inventing, creating strategies, criteria, and procedures, to solve problems using creativity and discrepant or similar thoughts. Then, heuristics is considered to use the experiences of the individual or a team of individuals, to solve a problem in the most viable way.

Likewise, Venegas (2021) argues that the V heuristic is a metacognitive tool due to its structure and the way it is developed, facilitating learning through theoretical and methodological issues that in an interrelated manner allows the construction of knowledge, providing solutions to problems based on competencies. In this understanding, metacognition, according to Jaramillo & Simbaña (2014), is the ability to self-regulate learning processes, in it are involved a set of individual actions linked to knowledge, regulation, and control of cognitive mechanisms to achieve, evaluate, and produce information, in the eagerness to learn. Mosquera (2019) tells us that metacognition is understanding of understanding, thinking about thinking, knowing about knowing, and becoming aware of one's awareness and higher-order thinking skills.

On the other hand, for there to be authentic research, even for any action of inquiry, it is necessary to know how to think (Martínez, 2011). In this regard, Lucio (2010) emphasizes that it is necessary to integrate knowledge with know-how, i.e., the concept with daily practice, both are the product of knowledge.

Therefore, this strategy contributes to the development of information to be converted into knowledge. In the structure of the heuristic V, knowledge is a construct of people's interests, which in turn can be structured and analyzed from a problematic (Lozano, 2017). For knowledge to be acquired and learning to be meaningful through Bob Gowin's V Heuristic, Bermeo-Yaffar et al. (2016) say that it must include each one of its elements.

Methodology

To carry out the systematic review, terms were used regarding the need for the analysis of Bob Gowin's heuristic V diagram, to make known its usefulness at the level of scientific inquiry in the classroom, specifically related to the natural sciences, science, and technology. The following is the methodology used for its review, which is expressed in the scheme (see Fig. 1).

In the initial search, scientific research was reviewed considering the database of the Virtual Library of the Universidad Cesar Vallejo, specifically in the databases Scopus, Science Direct, and Latindex, using the terms "V Heuristic", "Gowin's V", later the term "scientific inquiry" was added; likewise, the search in English was used: "V heuristic", "Gowin's V", "scientific inquiry" and "V heuristics and scientific inquiry" with no success in the results.

Then, a new systematic search was performed, considering terms such as "The V heuristic" associated with the term "scientific inquiry" obtaining 13014 results that contained in many of the information that were not associated with the needs of the research.

The systematic review performed, or scientific literature disseminated regarding Gowin's Heuristic V Diagram concerning the scientific inquiry, was selected according to the guidelines of the PRISMA statement (Urrutia & Bonfill, 2010). In the systematic search, more specific terms such as "Gowin's V diagram" and the term "Gowin's V diagram in meaningful learning", "Gowin's V diagram and scientific inquiry" and "The Heuristic V and the knowledge of physics and chemistry" were considered, the new systematic search yielded a total of 414, of which the selection of articles with the exclusion analysis criteria and those considered to be of quality was made.

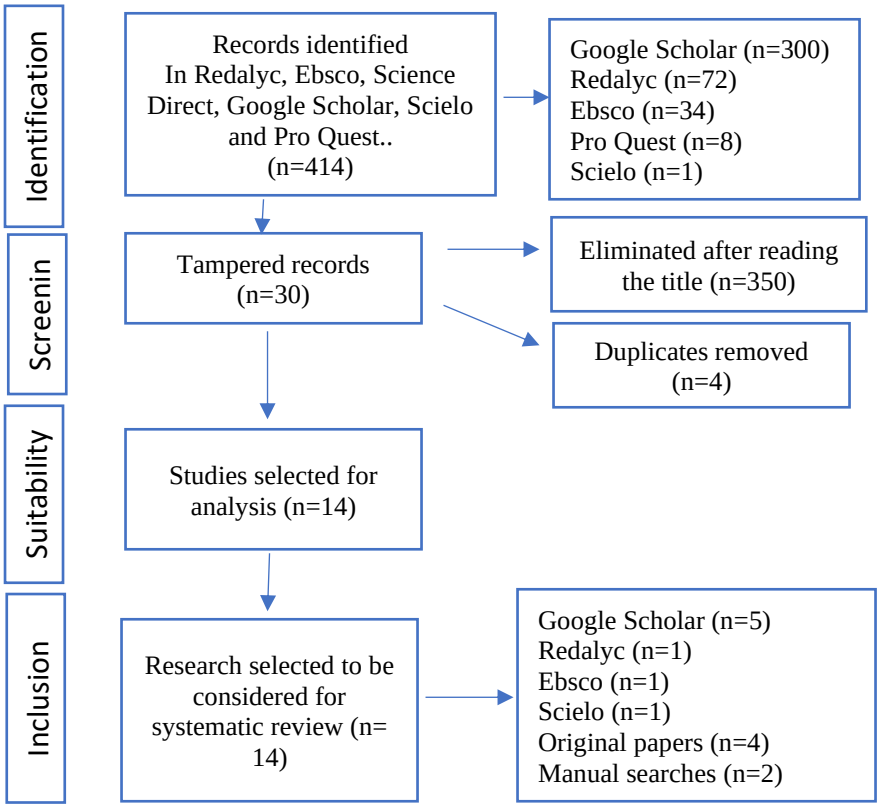
For the selection of quality information, search filters were considered as year of publication (2017 to 2021), language, Spanish, Portuguese and English, discipline, education; and all countries. Of the 414, specific numbers related to each database is as follows: 300 in Google Scholar, 72 in Redalyc, 34 in Ebsco, 8 in Pro Quest, and 1 in Scielo. From this search, many of the indexed journals did not meet the

expectations of the study, so it was considered to consult only 50 analytically.

Of the 50 articles analyzed, only 14 articles were included according to the objective of the research, to analyze the scientific contributions to the scheme of the V Heuristic in scientific inquiry. For this purpose, the proposed and/or applied graphs were considered in which the authors diagram flexibly, considering creativity, concepts, methodologies, problems, and starting questions or conductive threads, likewise in other articles the questions that guide each of the parts that comprise the graph are considered creatively; finally, the articles that allow outstanding contributions to the research are selected.

Data and Results

Figure 1. PRISMA flowchart in four levels (According to statement PRISMA Urrutia & Bonfill 2010)



From the documents found, the following metadata were selected: The title of the article, the year of the publication, the relational name, the country from which each publication came for related to what is intended, the content of the graphs, the questions to consider and the level to which they were directed, as well as the subject to consider in the studies since the scientific inquiry starts from a problem that must be approached from what the student observes based on a real problem that presents and must be solved with the knowledge he has and these be complemented with those that are provided in the additional information.

The contributions and conclusions reached in terms of research and inquiry were also considered. Therefore, 5 articles extracted from Google Scholar were used, 1 per article from the Redalyc, Ebsco, and Scielo databases, likewise 4 original review articles and/or theses were considered for the results obtained for a better analysis, and finally, 2 manual searches were considered, which arose

from the need to exhaust relevant information to explain what is intended.

Results

The results found in the review of the 14 research papers were structured as follows: General aspects to be considered in the heuristic V diagram; the questions to be considered in Gowin's V; the contributions and conclusions reached in investigative and inquiry matters related to Gowin's V.

General aspects to be considered in the Heuristic V diagram.

This aspect is referred to the structure presented in a general way, which will allow an organization according to the needs of those who structure the heuristic V. It reflects in a general way the three or four fields to be used according to the cited authors (Table 1).

Table 1. General aspects to consider in the heuristics V-diagram.

Authors	General aspects in the elaboration of the heuristic V-diagram
Mejía (2018)	It starts from an event or objects to be investigated. Comprises the central question, which leads to the selection of the conceptual framework, orients refutes, and builds new knowledge through the methodological framework. The conceptual framework; seeks regularities to build concepts and establish conceptual structures, which can generate models in search of principles that lead to laws to build theories that depend on underlying philosophies. Methodological framework; uses records that are validated with facts that with the appropriate means lead to transformations that allow obtaining results to make interpretations, explanations, and generalizations to arrive at knowledge and value judgments
Figueroa and Veliz (2019)	The structure starts from events and objects, to generate central questions that allow reciprocal, active, and constant interaction. The conceptual part (Theory); comprises concepts, definitions, principles, theories, philosophies, and conceptions. The methodological part (Action); considers records, transformations, and results; interpretations and explanations, statements about concepts, and assessment.
Stella (2017)	Problem question (Center) which guides and orients the research. Theoretical/conceptual domain (Thinking) (left part); principles related to the concepts are considered for the understanding of events and theories that help in the investigation. Experimental or practical procedure (lower part or vertex). Observations and results (right part) obtained in practice.
Jiménez & Villegas (2020)	Central question At the base; it comprises the natural events to be analyzed and the objects of study and/or events. Theoretical-conceptual domain (left side) here is the process where knowledge is generated. Methodological domain (right side) to generate or produce knowledge.
Rivera et al. (2018)	Part of central questions. The conceptual domain; includes; Hypotheses: basic assumptions to start the research; Theories; Principles and Laws. Methodological domain, includes; Methodologies; How am I going to do it? Events and conclusions of the research, are united in the vertex.
Herrera and Sánchez	Base; events or objects, Center; formulation of questions. Conceptual or knowledge side (left); conceptual aspects, principles, theories, etc.

(2019)	Doing or procedural side (right). Methodological elements: data, records, transformations, knowledge, and value statements.
Vélez (2021)	He considers four spaces: Problem statement (center). Objective (vertex). Theoretical foundations (left side). Research fundamentals (right side).
Sánchez (2020)	Problems to be solved Conceptual elements Experiential elements

Source: Own elaboration.

From these data, it is possible to include results such as The event or object to be investigated, which allows the inquirer to consider initial situations or as they refer in the area of science and technology significant situations, which, put in the research, call the attention of the learner to generate a possible answer. The central question: as its name indicates, is the essential part of the scheme because it leads to the resolution of the problem. The conceptual framework: considers previous conceptual structures with those concepts that are presented to them, to build new knowledge. The methodological framework: allows obtaining results, using tables, and diagrams, among others, to make interpretations, explanations, and generalizations that generate value judgments or knowledge obtained.

Questions to Consider in the structure of Gowin's V, Heuristic or Epistemological.
This aspect refers to the interrogative structure presented. In this review the four fields to consider are presented, for the usefulness of what is to be applied, from the most elementary with few structured fields to those that present many questions per field or more structured aspects in their elaboration (Table 2).

Table 2. Questions to consider in Gowin's V.

Authors	Central question	Part or object	Conceptual Framework	Methodological Framework	Other Aspects
Morantes et al. (2018)	Central question: What do I want to know? Objectives: What do I want to investigate? What do I want to prove, contribute or modify? Variables What is the independent variable? What is the dependent variable?	Events: Which events/objects do I use and how do I arrange them?	What concepts do I need? How does the phenomenon under study happen? What general or specific areas explain the subject? Why does it happen? What are the tentative answers?	What do I measure directly? How do I organize my ideas and data? Are the objectives met? Is the theoretical model verified with the experimental one? What did I learn about what I wanted to know? What practical implications do I find in the experience and the event generated? What is the use of what I learned? What standard should I use for reference? What specific and	

				lengthy details should I add to complete the theory and experimentation?	
Figueroa and Veliz (2019)	What is the purpose or object of the activity (1)?	What is the problem? (2)	What are the causes that influence the problem (5)? How would you describe the problem? (7) What are the theoretical concepts of the problem (9)? What laws and principles are involved? (11)	How do I record and organize the data (4)? What are the steps to follow in the experimentation (6)? What are the results of the experimentation and what is the conclusion (8)? How do I transfer what I learned into daily life (10)?	Hypothesis (3)
Palomino (2018)	What do I want to know? (1)	Problem (Event/ Objects) (2)	Vocabulary of key concepts. (5) What areas or fields of knowledge explain the problem? (6) How to solve the problem (9)	What do I need to solve the problem? (3) How do I organize my ideas and data (4)? What do I know about the problem? (7) What is the use of what I know? (8)	
Jiménez & Villegas (2020)	What? Who? How? When? Where? Why? What for? Since when?	What subject will be studied?	Philosophies, theories, principles, and laws; key concepts	registers, transformations, knowledge assertions; value assertions.	
Rivera et al. (2018)	What do I want to know? What do I want to check? What do I want to modify?	What am I getting at?	Why does it happen? The hypothesis is... What concepts do I need? What law or principle applies?	How am I going to do it? Selection of instruments. Definition of procedures. Measurement of the object of study. Identification of behaviors. Recording of results	Hypothesis
Hoyos (2017)	Relevant guiding	Learning object (2)	Curricular content (7)	Methodological Route (8)	

	question (1)		Phases of: Exploration, investigation, and synthesis. (6) Comprehension performances. (5) Thread of understanding. (4) Comprehension goal. (3)	Evidence of understanding (9) Conclusions and recommendations (10)
Tecpan & Hernández (2019)	What is the question to be answered?	Event, fact, experience, problematic situation	Concepts. Conceptual structures. Principles. Theory.	Recording or data collection. Transformation and analysis. Results and interpretations. Knowledge statements.
Vélez (2021)	Inquire	To raise hypotheses. Objective	Explain	Observe

Source: Own elaboration.

Regarding the questions to be considered in the structure of Gowin's V, Heuristic, the four fields to be considered were presented, for the utility to be applied, from the most elementary with few structured fields to those that present many questions per field or more structured aspects to be considered in their elaboration. Mostly the central question is used: What do I want to know? In the part or Object: Where do I want to get to? in the Conceptual Framework: What key concepts will I use? and How will I solve the problem? And in the Methodological Framework: What do I need to solve the problem? and What is the use of what I know? These generic questions contribute to what is to be achieved in the research inquiry.

The numbers presented are the orientations of where (1) starts and where (9) (10) (11) the structure ends.

Contributions and conclusions on research and inquiry regarding Gowin's V.

Part of the reviews leads us to consider the contributions made by research. It presents the importance of the usefulness of the heuristic V for meaningful learning, problem-solving, scientific inquiry, and metacognition, essential for its application in the construction of new knowledge based on the resolution of situations in their context and their lives (Table 3).

Table 3. Significant contributions of studies conducted on the effectiveness of heuristic V.

Authors	Significant contributions
Mejía (2018)	It uses aspects of the context for its elaboration, as well as thinking, feeling, and doing in the production of new knowledge. The pedagogical strategy V heuristic can be used by teachers in the eagerness of efficient significant learning in the students, since with this methodology the students use both hemispheres of the brain, left and right, annexing logic

	and creativity respectively in their learning
Figueroa and Veliz (2019)	Through the application of the heuristic V, significant learning is enabled, and with statistics, highly significant positive change is observed.
Stella (2017)	The V diagram is a tool that allows you to interrelate events, processes, or objects, to relate them to what you know and what you need to know in the construction of a new concept.
Méndez and Daza (2018)	The V Heuristic is a strategy that can be used in different ways; the teacher can use it as an explicit outline of what he/she intends to teach, and students can use them as synthesis, evaluation, or metacognition. These allow the systematization of an idea, expressions, discussions; concretization, and the answer to questions to investigate.
Rivera et al. (2018	This pedagogical model is useful to develop investigative competencies because it allows the achievement of significant learning, it also favors the growth of reflective thinking, and allows the development of the ability to assimilate information and organize it in a scheme.
Sánchez & Herrera (2019)	All inquiry includes theoretical models, laws, and concepts. Gowin's V diagram facilitates inquiry, allowing the development of scientific competencies, to bring them closer to problem-solving, considering concepts, methods, attitudes, and meaningful and collaborative learning.
Doria and Lozano (2018)	The use of the heuristic V, allows inquiry experiences in the students, starting from the formulation of questions, and their consequent answers, in it integrates the experience of the person as a method, and the participation of the student in his learning, the learning is given by thinking and the results are the construction of those thoughts.
Vélez (2021)	Heuristic V reinforces the development of scientific skills in students by considering inquiry, observation, explanation, and hypothesis creation.
Castro and Vega (2021)	The application of Gowin's V awakens the interest in learning physics, this is because of not having a laboratory for its development, therefore, it allows solving scientific problems flexibly and dynamically, likewise, the metacognitive process that generates the heuristic V motivates the student in the learning of scientific sciences.
Ortiz y Barreto (2020)	The heuristic V diagram is a strategy or tool that can be used schematically for problem-solving and the achievement of meaningful learning.
Martinelli (2019)	The V-diagrams, after their elaboration by the students, allow the evaluation of the experimental activities, the recorded data, calculations, interpretation of results, conclusions, and the ability to identify key concepts in the research; all this by the teacher for the assessment and/or feedback of the work done.
Venegas (2021)	The use of Gowin's heuristic V, influences students' abilities to reason, analyze, systematize, interpret, organize and develop research skills.

Source: Own elaboration.

Regarding the contributions and conclusions of research and inquiry. The important use of the heuristic V for meaningful learning, problem-solving, scientific inquiry, and metacognition, reasoning, analyzing, systematizing, and interpreting results, are essential for its application in the resolution of situations in their context and their lives.

Discussions

The methodological strategy V Heuristic has as structure a V that according to Bob Gowin, comprises 3 spaces: the central question, the conceptual framework, and the methodological framework, which, in the study, as Palomino (2018) says, despite seeing that at the base of the V are the events or facts proposed since its inception by Gowin, this

was not considered as a section of the questions by the author. However, for a better understanding, most scholars consider the scheme with 4 spaces or sections, such as an Event or object to be investigated, in most cases, it is the beginning of the inquiry. The central question leads to the selection of the conceptual framework, which orients, refutes, and builds new knowledge through the methodological framework. The conceptual framework; establish conceptual structures, principles, laws, philosophies, and conceptions. Methodological framework; generates and uses records, transformations, results, interpretations, explanations and generalizations, knowledge, and value judgments. In contrast to the aspects mentioned above, Sanchez (2020) considers only three sections, namely, problems to be solved, conceptual elements, and experiential elements.

Regarding the questions to be considered, each author independently of their inquiry needs to consider the pertinent ones in the diagram. However, most revolve around the most common ones, which, for sustenance, Palomino (2018) is considered: Central Question: What do I want to know? Conceptual Framework: What key concepts will I use? What areas or fields of knowledge explain the problem? How will I solve the problem? Methodological Framework: What do I need to solve the problem? How do I organize my ideas and data? What do I know about the problem? What is the use of what I know? In the Part or Object section, they consider: Morantes et al. (2018) What events/objects do I use and how do I arrange them; Figueroa and Veliz (2019) What is the problem; Jiménez & Villegas (2020) What topic will be studied; and Rivera et al. (2018) What do I want to get to? In the order of Other Aspects, Figueroa & Veliz (2019); Rivera et al. (2018), estimate the hypothesis. For his part, Veliz (2019) takes into account the hypothesis within the part or object. Morantes et al. (2018), in the central question section, consider the objectives What do I intend to investigate? What do I wish to prove, contribute or modify? And the variables What is the independent variable? What is the dependent variable?

The most relevant contributions that were considered revolve around the significance of learning (Figueroa and Veliz, 2019). The usefulness at the teacher and student level (Mejía 2018) and (Méndez and Daza, 2018). Regarding learning, it allows synthesis, the growth of reflective thinking, and develops the skill of assimilating information and being able to organize it in a scheme; likewise, it allows an evaluation and metacognition of what was learned (Rivera, Carranza, and López, 2018). Likewise, the use of the heuristic V allows inquiry experiences in students, starting from the formulation of questions, and their consequent response, in it integrates the experience of the person; learning, which is given by thinking and the results are the construction of those thoughts (Doria & Lozano, 2018)). Another relevant data exposed is that the V heuristic reinforces the development of scientific skills in students, for it is considered, inquiry, observation, explanation, and the creation of hypotheses (Venegas, 2021) and (Sanchez & Herrera, 2019). From these contributions, relevant importance can be assigned to the use of the heuristic V to allow scientific inquiry in a flexible way, which in turn can be part of the learning sessions, so that research can be carried out from the classroom in a graphic, sequenced way and with precise horizons in the resolution of everyday problems.

Conclusions

The analysis of the scientific contributions to the Heuristic V diagram allows reaching the conclusion that the understanding and construction of the students' knowledge, through the development of the heuristic V diagram is an easy-to-use tool, considering in its structure the essential and increasing parts of what is to be achieved in research.

To achieve learning based on scientific inquiry, the diagramming of Gowin's V, allows to organize the concepts and methodologies, starting from a key question proposed from a situation fact or event that the student will manage to solve from the

observation, using his experiences a priori; in its construction is considered the conceptual domain; thinking, the methodological domain, doing; both parts of the design are oriented by questions that will be answered based on what is intended to solve from the angular part.

The diagram and the steps to be considered can be modified in a flexible way and according to the needs of inquiry; the scheme can be used from the initial level to the higher level, considering its structure, the degree of complexity from the simplest to the most complex; likewise, it can be applied to all areas and/or subjects according to individual and group needs; in this way, both teachers and students are benefited by this pedagogical strategy, which allows reflection, analysis, criticality for the consideration of the elaboration of the same and the construction of new knowledge.

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