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# Construction of Educational Sequences Through the Morganov-Heredia Technique

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***Abstract:*** *The social context of the educational phenomenon is closely linked to the reflection of teaching practice. Reflection that aims to identify the knowledge that the student must learn in different circumstances. But reflection without action is diluted in the becoming of being-in-the-world. In this context, the teacher requires methodological strategies that enable him to develop educational sequences that facilitate student learning. In this line of reflection and through the analysis of the Morganov-Heredia technique, the study was carried out with the aim of exposing the procedure of this technique in an accessible and practical way, to be used as a tool to plan and organize the courses it teaches the teacher. The Morganov-Heredia technique is a semiotic process that integrates the theory of graphs and the algebra of matrices to the structural analysis of the educational phenomenon to determine the articulation, structuring and organization of the elements that comprise it, making it possible to represent the sequence of "units of information" linked to the educational process. In the development of the article, the characteristics of the following stages are exposed to apply the technique: construction of the binary matrix, articulation of information units, structuring of information units, organization of information units, and educational sequence of the information units. It concludes by recognizing that applying the technique is a laborious process, although satisfactory as it provides the foundation of a scientific nature to build educational sequences.*

***Key Word****: Morganov-Heredia technique, educational sequence, educational phenomenon, educational structure, educational planning.*

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## I. Introduction

The experience that arises from being-in-the-world of life provides evidence that education is a social phenomenon that takes shape in a process that is historically determined [1]. Operating the process that underlies the educational phenomenon, allows the individual to adapt and modify the material conditions of life, either individually and/or collectively. The transformation of the world of life through the material conditions in which the human being develops, is aimed at satisfying his basic needs, both natural and social [2]. Currently, it is promoted that the educational process of teaching and learning is generated in an environment that allows the student to be consciously more critical, in such a way that by being-in-the-world, its practice leads to effective action and transformative praxis on nature [3].

In this conceptual context, the COVID-19 pandemic, an event of a biological nature that has had a high social impact when implementing strategies aimed at containing the spread of the SARS-CoV-2 virus [4], has led educational systems to face multiple challenges to implement online educational processes [5]; resulting in the transformation and adaptation of teachers and students to alternative ways to develop school work. Undoubtedly, the computational infrastructure, training in the use of information and communication technologies (ICT) is important for the development of courses in distance education modalities, and training in new didactic strategies. But it is also important to bear in mind that, for each class taught online, there are underlying aspects such as activity planning, search for new material, design of audiovisual material, design of practice material, reception, correction and return of tasks, individual follow-up of each student, answer to questions and queries, preparation of newsletters and reports, meetings of teaching work teams.

Among all these aspects that require the adaptation of the teacher for the development of his educational task, the planning of the courses and the development of learning activities stand out, which translate into the following questions: how to implement the activities to complete the program of the course? What are the essential minimum contents that students must learn? What are the learning activities that students must carry out? How to determine the importance of the contents that students must learn in a fundamental way? How to establish the sequence of learning contents to facilitate the construction of learning activities and, consequently, student performance?

The reflection of educational practice oriented by these questions, directs the gaze towards the horizon of understanding delimited by the systematization of teaching, as an approach that resorts to the triad "reflective practice-theory-practice" as a process for construction and production of knowledge [6] that will go from the epistemological position of the teacher to the student's learning activities. This process involves developing the following stages (Figure 1):

- Epistemological foundations of the educational praxis of the teacher.
- Content analysis to determine units of information, whether it is educational objectives, professional skills, tasks to be carried out, topics to be taught, concepts to be developed or educational experiences to be systematized.
- Educational structural analysis through the Morganov-Heredia Technique, used to develop the sequence of information units.

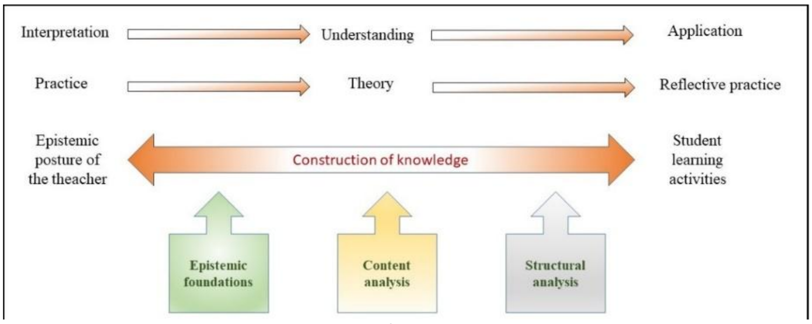


Figure 1: Schematic representation of the teaching transition process with points of incidence derived from the analogy between the triad "practice-theory-reflective practice" and the Gadamerian hermeneutical circle.

In analogy with the Gadamerian hermeneutical circle (interpretation-understanding-application) [7,8], the triadic scheme of reflective practice makes it possible to establish the mediation between man and the world through interpretation [9], that is, to identify facts from the observation of the practice that the teacher performs on a daily basis in the classroom, whether physical or virtual. In the interpretation of teaching practice, it is sought to make the meaning of the events that are generated in the dialectic of teaching and learning understandable. Understanding, like theory, has a two-way sense: on the one hand, the pragmatic interest and on the other, the theoretical interest itself [10]. In the educational phenomenon, understanding articulates both interests by resorting to theoretical foundations that give meaning and coherence to teaching practice. Thus we have the teaching practice that is being built empirically and that which is based on the reflective practice enunciated by Donald A. Shön [11] and Phillippe Perrenoud [12]. Finally, in the occurrence of the "know-how" that underlies hermeneutical understanding, reflective practice refers to the moment of application of the hermeneutical circle. For Gadamer [8], understanding without applying implies that he has not yet been understood; that is, reflective practice without transfer from theory to practice is not yet reflective practice.

Bearing in mind the previous analogy, teaching in times of health contingency requires motivation to seek, interpret, understand and apply strategies that facilitate the educational process. This is the case of the Morganov-Heredia technique, used to establish the sequence of the contents of a course, through the articulation, structuring and determination of the pedagogical sequence. Through the hermeneutical analysis of the Morganov-Heredia technique, the study was carried out with the aim of exposing the procedure of this technique in an accessible and practical way, to be used as a tool to plan and organize the courses taught by the teacher. To meet this objective, the development of the article begins with the description of the technique to then give way to the presentation of the procedure described by Solano [13], Huerta and Heredia [14], structured in five stages.

## II. Description of the Morganov-Heredia technique

The Morganov-Heredia technique was developed in 1966 by I. B. Morganov [15] to develop educational programs using graphic methods that allowed to determine the teaching sequence of the contents during the educational process [14]. In Mexico, it was developed and applied to the analysis of the educational process by Berta Heredia, José Huerta [14] and Guillermo Solano Flores [13,16] in the seventies of the last century; and since 2010 it has been recommended by the Ministry of Public Education to prioritize the competencies that are developed in educational programs [17,18].

The Morganov-Heredia technique is conceptualized as a semiotic process that integrates the theory of graphs and matrix algebra to the structural analysis of the educational phenomenon to determine the articulation, structuring and organization of the elements that comprise it, thus making it possible to represent the sequence of different information units linked to the educational process [13,14]; in a way that makes it possible to systematize educational experiences to facilitate and harmonize student learning [17]; based on the transfer of knowledge and the antecedent-consequent relationship [19].

The technique consists of the elaboration of a binary double-entry matrix in which the relationship between each of the “information units” is represented numerically [14]. Based on this matrix, decisions are made related to the importance, relevance or requirement of an “information unit” to develop the next unit. Incorporating a process of reduction of the initial matrix, a graph is constructed from which, through the hermeneutical interpretation to analyze the information unit that precedes another, the construction of the educational sequence of the “information units” is derived [16]. It is important to note that the “information units” can be: educational objectives or professional competencies, subjects, modules, topics and contents. Remember that once the type of “information units” that will be used to make the matrix has been defined, this mode must be preserved throughout the process; In other words, subjects, themes or contents should not be mixed during the development of the Morganov-Heredia technique. The matrix that is developed is a rectangular arrangement of real numbers arranged in (n) rows and (n) columns, in which the different “units of information” that are being analyzed are located, in the same order, in rows and in columns [20].

Based on the algorithm developed by Solano Flores [13] to put the Morganov-Heredia technique into practice, the following stages are identified for the development of the technique:

- 1st stage: Construction of the binary matrix.
- 2nd stage: Articulation of the information units.
- 3rd stage: Structuring the information units.
- 4th stage: Organization of the information units.
- 5th stage: Educational sequence of the information units.

Next, the essential elements to carry out each of the previous stages are exposed.

## III. 1st Stage: Construction of the Binary Matrix

The construction of the binary matrix is the first stage of the Morganov-Heredia technique. This stage begins by expressing the purpose that is pursued to develop the technique; for example, “construct the educational sequence of the Epistemology of Natural Sciences course”. Furthermore, the “information unit” that will be used for the construction of the matrix must be clearly defined; for the exemplified case, it would correspond to the course topics.

Next, the list of "information units" that will be ranked is drawn up and the size of the matrix is determined, bearing in mind that it must contain the same number of rows and columns. Each element is assigned a progressive number for its identification (see figure 2).

Purpose: to construct the educational sequence of the Epistemology of Natural Sciences course

Information unit to be used: Topics of the Epistemology of Natural Sciences course

List of Information Units

| No. | Information Unit |
|---|---|
| 1 | Conceptual delimitation of epistemology |
| 2 | History of epistemology and its philosophical traditions |
| 3 | Scope of epistemology (technology and philosophy) |
| 4 | Epistemology as philosophy |
| 5 | Epistemology as a methodology |
| 6 | Epistemology as reflection |
| 7 | Knowledge phenomenology |
| 8 | General theory of knoeledge |
| 9 | Cognitive models |
| 10 | Models of scientific thought |

Design of binary Matrix

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |

Figure 2: Examples of the objective, information unit, list of units and design of the binary matrix that is carried out during the 1st stage of the Morganov-Heredia technique.

Subsequently, the identification number of the "information units" is placed in the first row and in the first column of the binary matrix, keeping the same order both in the rows and in the columns, as shown in figure 2; since in each cell the existence or not of sequence relationships between the "information units" will be indicated (21).

## IV. 2nd Stage: Articulation of the Information Units

The second stage of the Morganov-Heredia technique is oriented towards the analysis of the articulation of the “information units” and consists of identifying the relationships between each of them, following the descending order of the rows. To identify the relationship between the “information units”, a question is asked. If the answer to the question is "yes", a one (1) is recorded in the corresponding cell, but if the answer is "nay" a zero is recorded in said cell (0). At the end of a row, it continues with the next until all the cells of the binary matrix are filled [14].

The meaning of the question that is elaborated determines the efficiency of the analysis carried out to identify the relationships between the different “information units” (21). The question can present different modalities that give meaning to the answer and is determined by the previously elaborated purpose; Some examples are the following:

- Is the information unit "Em" indicated in row mj a condition for the information unit "Ex" in column nj? For example, is the information unit "Epistemology as reflection" a condition for the information unit "Epistemology as reflection"?
- Is the information unit "Em" indicated in row mj a requirement for the information unit "Ej" in column nj? For example, is the information unit "Phenomenology of knowledge" a requirement for the information unit "Cognitive models"?
- To develop the information unit "Em", is it necessary to develop the element "En" first? For example, to develop the topic “History of epistemology and its philosophical traditions”, is it necessary to first develop the topic “Conceptual delimitation of epistemology”?

When answering the question, it is important to keep in mind the possibility of four types of relationships (see Figure 3) [14]:

- **A and B unrelated**; that is to say, that the information of A is not contained in B, nor the information of B in A. For example, when we speak of "Epistemology as philosophy", the knowledge is not contained in "Models of scientific thought"; nor are the contents of the "Models of Scientific Thought" contained in "Epistemology as Philosophy".
- **A before B**; that is, it is a relationship between two units of information where the information of A is contained in B, but the information of B is not necessarily contained in A. For example, the knowledge of the “History of epistemology and its traditions Philosophical" are contained in the "Scope of epistemology (technology and philosophy)", but the contents of the "Scope of epistemology (technology and philosophy)" are not necessarily contained in "History of epistemology and its philosophical traditions".
- **B before A**; is a relationship characterized by the fact that B's information is contained in A, but A's information is not included in B. An example would be the case in which knowledge related to “Causality in Medicine” is contained in “Models of scientific thought”; but the contents of “Models of scientific thought” are not contained in “Causality in Medicine”.
- **A and B together**; expresses the relationship where the information of A is contained in B, as well as the information of B is included in A. This relationship represents a "cycle", since it is a closed path, where the origin and end of the path coincide in the same element. For example, the knowledge related to "Causality in Medicine" is contained in "Multicausality in Medicine"; reciprocally, addressing the topic "Multicausality in Medicine" necessarily refers us to the knowledge of "Causality in Medicine".

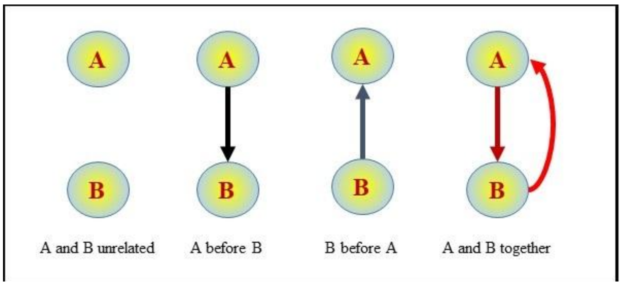


Figure 3: Schematic representation of possible relationships between two information units. (Image modified from Huerta and Heredia [14]).

According to Huerta and Heredia [14], the reasons that may be given for one “information unit” to be developed before (a requirement) of another may be the following:

- The logical order established by the discipline itself.
- That the understanding of one “unit of information” is a requirement for the understanding of another unit.

- The temporal sequence of the “information units”; in reference to the opportune moment when the "information unit" is necessary to facilitate the student, the transfer of knowledge to understand and/or apply another "information unit".
- The possibility that the “information units” are familiar or motivating for students.

This stage is concluded with the binary matrix that should express the record of the numerical representation of the relationships between the "information units". The matrix obtained has the following characteristics (figure 4):

- It has the same number of rows and columns.
- It presents a diagonal that is formed with the cells in which the "information unit" coincides in the same row and column, and the value of 0 is assigned, since the same information element is neither antecedent nor consequential of itself.
- The element diagonal divides the matrix into two triangles. Given the relationship between the different “information units”, the lower triangle contains zeros in all its cells, and the upper triangle expresses the binary relationship of the “information units”, corresponding to a triangular matrix.

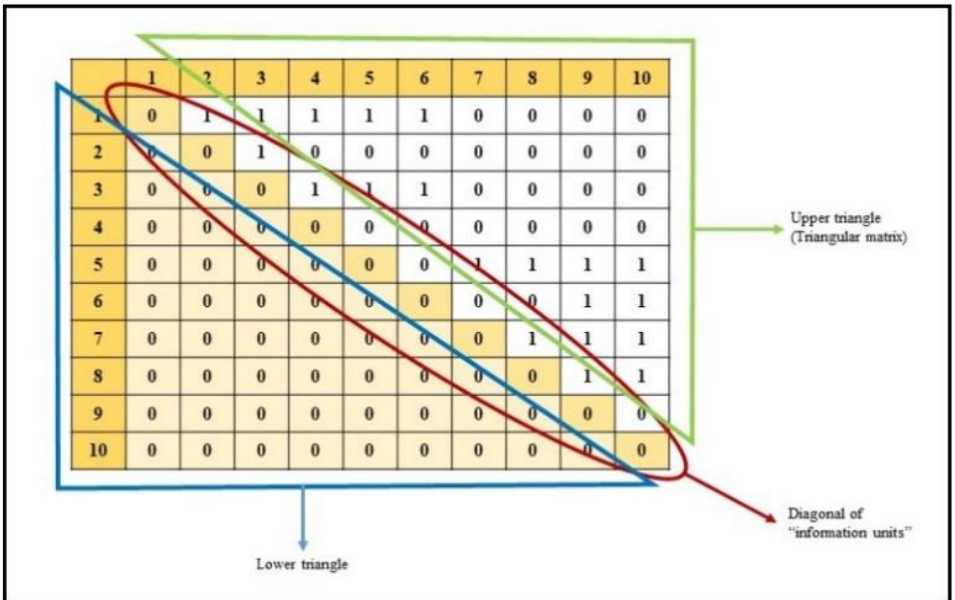


Figure 4: Characteristics of the binary matrix obtained during the 2nd stage of the Morganov-Heredia technique.

## V. 3rd Stage: Structuring the Information Units

The 3rd stage of the Morganov-Heredia technique is aimed at constructing the structuring of the "information units" and consists of representing the relationships between each of these units through vertices and branches. According to graph theory, the term "vertex" is used in this technique to express the "information units" previously defined and that have been expressed numerically in the binary matrix. In the same way, the term "branch" refers to the line that joins two vertices indicating the direction of the sense of the relationship between both vertices [22,23].

After completing the binary matrix, the 3rd stage begins with the identification of vertices and branches to build the corresponding graph in the next stage. Four types of vertices are described below (Figure 5) [14,19]:

- **Isolated vertex**: corresponds to the information unit that is not required by any other unit. Schematically it is represented as the vertex that does not have branches, nor does it have branches that come out of it. It is identified by observing that, in the rows and columns, there are only zeros; Therefore, it is pertinent to answer the following question: which information unit has only zeros in the columns and rows?
- **Source vertex:** corresponds to the content element that is a requirement of another element, but does not have any antecedent element. Schematically it is represented as the vertex from which at least one branch comes out and which is not connected to any. It is identified by observing that only zeros appear in the column and at least one 1 is present in the row; Therefore, it is pertinent to answer the following question: which element has only zeros in the column and at least one 1 in the row?
- **Intermediate vertex:** corresponds to the content element that is a requirement of another element, but in turn, requires another element as an antecedent. It is schematically represented as the vertex where branches arrive and also leave one or more branches. It is identified by observing that in the column

there is a one, and in the row there is also at least one 1; Therefore, it is pertinent to answer the following question: which element has at least one 1, both in the row and in the column?

- **Edge vertex:** corresponds to the content element that is not a requirement of any other element, but in turn requires another element as an antecedent. Schematically it is represented as the vertex to which branches arrive, but no branch leaves. It is identified by observing in the matrix that there are only zeros in the row, and at least one 1 in the column; Therefore, it is pertinent to answer the following question: which content element has only zeros in the row and at least one 1 in the column?

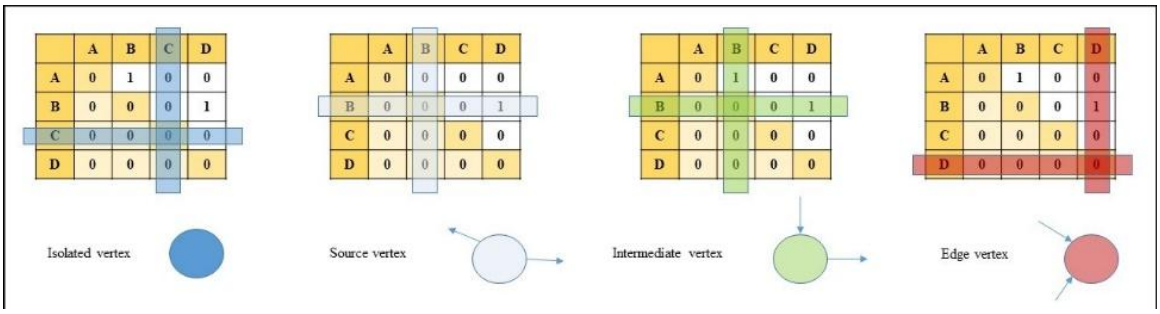


Figure 5: Schematic representation of vertex identification during the 3rd stage of the Morganov-Heredia technique.

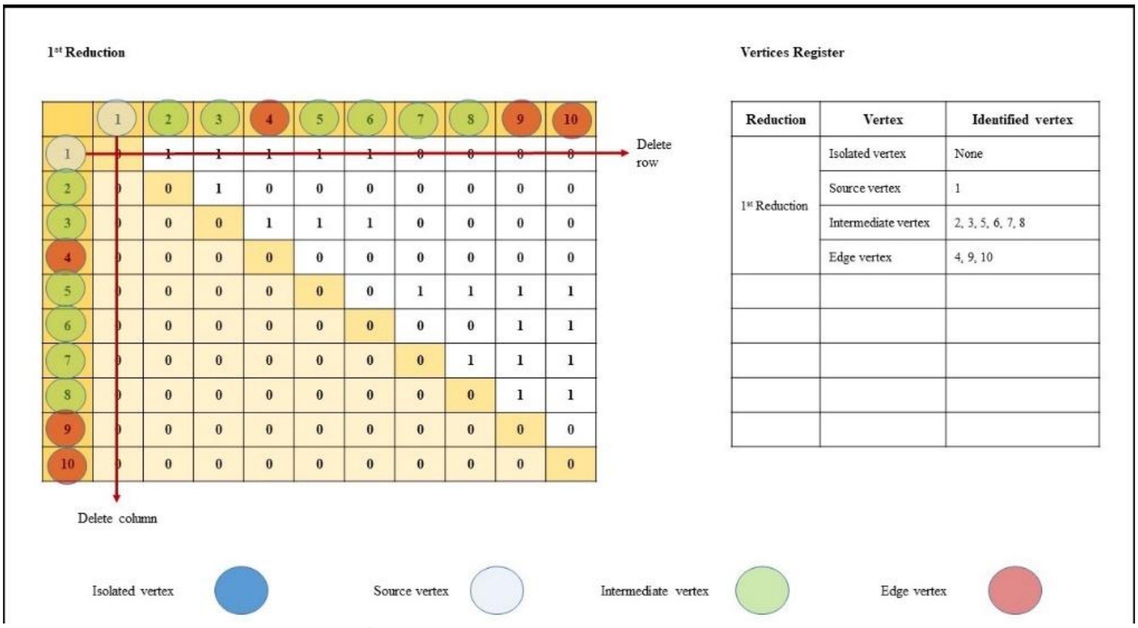


Figure 6: Representation of the initial binary matrix and the vertex register. The arrows show the row and column that must be eliminated to perform the 1st reduction described in the 3rd stage of the Morganov-Heredia technique.

Taking into account the previous concepts, the vertices are identified and the first reduction of the initial matrix is carried out (13,14,19). For this process, first the isolated vertices are identified, giving an answer to the question: what “information unit” has only zeros, both in the columns and in the rows? The vertices identified are recorded in a table prepared for this purpose. Next, the source vertices are identified, answering the question: what “unit of information” has only zeros in the column, and at least 1 in the row? The identified vertices are recorded. Subsequently, the intermediate vertices are identified, giving an answer to the question: what "information unit" has at least 1, both in the row and in the column? Identified vertices are also recorded. Finally, the edge vertices are identified, giving an affirmative answer to the question: which unit of information has only zeros in the row and at least one 1 in the column? Identified vertices are also recorded (see figure 6). After having identified and registered the different vertices, we proceed to eliminate the isolated vertices and the source vertices from the initial binary matrix, both in the column and in the corresponding row, as shown in figure 6. This process corresponds to the first reduction and will allow to identify the first level of generalization in the construction of the graph.

With the binary matrix obtained by eliminating the isolated vertices and the source vertices, identified in the first reduction, we proceed to identify the source vertices again, for which the question will be answered:

which unit of information has only zeros in the column and at least one 1 in the row? On this occasion, the identified source vertices of the rows and columns of the binary matrix corresponding to the 1st reduction are also eliminated, as can be seen in figure 7.

4th Reduction

| | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 7 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Registry of delete vertices

| Reductions | Vertices | Vertex removed |
|---|---|---|
| 1st reduction | Isolated vertex | None |
| | Source vertex | 1 |
| 2nd reduction | Source vertex | 2 |
| 3rd reduction | Source vertex | 3 |
| 4th reduction | Source vertex | 5, 6 |
| 5th reduction | Source vertex | 7 |
| 6th reduction | Source vertex | 8 |
| 7th reduction | Edge vertex | 4, 9, 10 |

6th Reduction

| | 4 | 8 | 9 | 10 |
|---|---|---|---|---|
| 4 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 1 | 1 |
| 9 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 |

7th Reduction

| | 4 | 9 | 10 |
|---|---|---|---|
| 4 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 |

Figure 7: Representation of the binary matrix in different reduction stages and the registration of eliminated vertices. The arrows show the row and column that must be eliminated to carry out the corresponding reduction to conclude the 3rd stage of the Morganov-Heredia technique.

The eliminated vertices are registered, indicating the reduction number to which it corresponds, since it represents the second level of generalization when developing the graph (13,14,19). This process is repeated until only zeros are present in the columns; that is, when there are only edge vertices in the matrix (Figure 7).

When only edge vertices are identified in the last resulting binary matrix, this stage is concluded and the formal representation of the articulation and structuring of the “information units” begins, finally obtaining a pedagogical sequence that represents the educational process.

## VI. 4th Stage: Organization of the Information Units

The fourth stage of the Morganov-Heredia Technique consists of the elaboration of the corresponding graph in which the organization of the “information units” is shown, providing the temporal sequence of the educational process. A graph is defined as a collection of points called vertices joined by lines called edges; and each edge joins two points. In this stage, the integration of the records of isolated vertices, source vertices, intermediate vertices and edge vertices, identified in the 3rd stage of the technique, is carried out.

For the development of this stage, the vertex record obtained in each of the previously elaborated reductions must be reviewed, and the following is done (Figure 8) (13,14,19):

- Each of the registered vertices is drawn according to the reduction made; for example, in the first reduction, the isolated vertices and the identified source vertices are drawn. The representation obtained corresponds to the first level of generalization.
- Next, and above the first level, the vertices registered in the second reduction are drawn. The representation obtained corresponds to the second level. This process is repeated until all the reductions are drawn, thus obtaining a set of levels ordered in ascending order.
- After having drawn the vertices, an arrow is drawn that establishes the sense of antecedent-consequent (→) between two vertices, one located in the immediate superior level, as long as the relation is specified in the initial binary matrix. It may be asked: does any source vertex of the upper level have as a prerequisite some vertex of the lower level? If, when consulting the initial binary matrix, the answer is yes, the arrow is drawn joining the vertices related to each other.

- Check at the lower end of the graph, the correspondence of the initial source vertex. This vertex will start the sequence of the graph.
- Identify the presence of cycles. In the event that a cycle is identified, modifications must be made to the content and the corresponding binary matrix, in order to eliminate the cycles. To eliminate the cycles, consult the articles by Huerta y Heredia [14], and Solano Flores [13].
- Corroborate the correct location of the edge vertices identified in the initial binary matrix.

[A]

| Reductions | Vertices | Vertex removed |
|---|---|---|
| 1st reduction | Isolated vertex | None |
| | Source vertex | 1 |
| 2nd reduction | Source vertex | 2 |
| 3rd reduction | Source vertex | 3 |
| 4th reduction | Source vertex | 5, 6 |
| 5th reduction | Source vertex | 7 |
| 6th reduction | Source vertex | 8 |
| 7th reduction | Edge vertex | 4, 9, 10 |

[B]

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

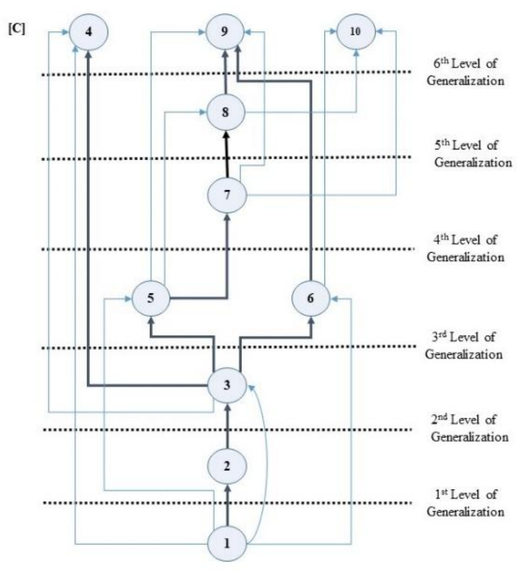


Figure 8: Schematic representation of the elaboration of the graph. The deleted vertex record table is shown in [A]; in [B] the initial binary matrix, and in [C] the graph obtained at the conclusion of the 4th stage of the Morganov-Heredia technique.

It is important to point out that, in a practical way, the 4th stage can be developed simultaneously with the 3rd stage.

## VII. 5th Stage: Educational Sequence of the Information Units

The last stage of the Morganov-Heredia technique consists of the construction of the educational sequence of the analyzed “information units”, based on the interpretation of the graph obtained in the previous stage (23). In our case, to develop this stage we resort to the hermeneutical approach applied to the field of health sciences (24), due to the possibility it offers as a horizon of understanding in the analysis of the logical sequence of the information units.

Once the graph has been obtained as shown in section “C” of Figure 8, the next step is to carry out the interpretive analysis of the graph to understand the route that makes it possible to facilitate learning and transfer of the knowledge that is represented in the "Information units". It should be remembered that the graph is the product of successive reductions of the initial matrix.

In the obtained graph, the relationships that exist between the "information units" are shown, attending to the antecedent-consequent criterion, pointing out different routes to structure the educational sequence; Furthermore, as Huerta and Heredia [14] point out, "the resulting structure highlights the direct transfer of one vertex over another and allows us to realize the transfer by transitivity, that is, how one element is a requirement of others in an indirect way" (p. 7).

To build the educational sequence, it begins by identifying the ideal path through which one can travel from the source vertex of the first level of generality, to the edge vertices of the last level of generality. For example, when looking at part “C” of figure 8, the sequence that can be projected according to an ideal trajectory would be the following: (1→2→3→4→5→6→7→8→9→10). Next, the identification of other possible routes is carried out; for example, let's list the following:

- Ideal trajectory = (1, 2, 3, 4, 5, 6, 7, 8, 9,10)
- Alternative trajectory 1 = (1, 2, 3, 4, 6, 5, 7, 8, 9, 10)
- Alternative trajectory 2 = (1, 2, 3, 6, 5, 4, 7,8, 10, 9)

To select the actual path that will be used to integrate the educational sequence, each identified path is analyzed by applying the criteria of adjacency, direct and indirect transfer, and vertical and horizontal transfer (13).

The adjacency criterion refers to the logical sequence between the "information units" attending to the logical antecedent-consequent relationship.

The direct transfer criterion recovers the logical sequence between the “information units” based on the use of previously learned knowledge, to understand, apply or enter immediately and directly to learn new knowledge. In the case of the indirect transfer criterion, the logical sequence exposes the “information units” that require passing through other units that have been previously learned, so that knowledge is recovered indirectly.

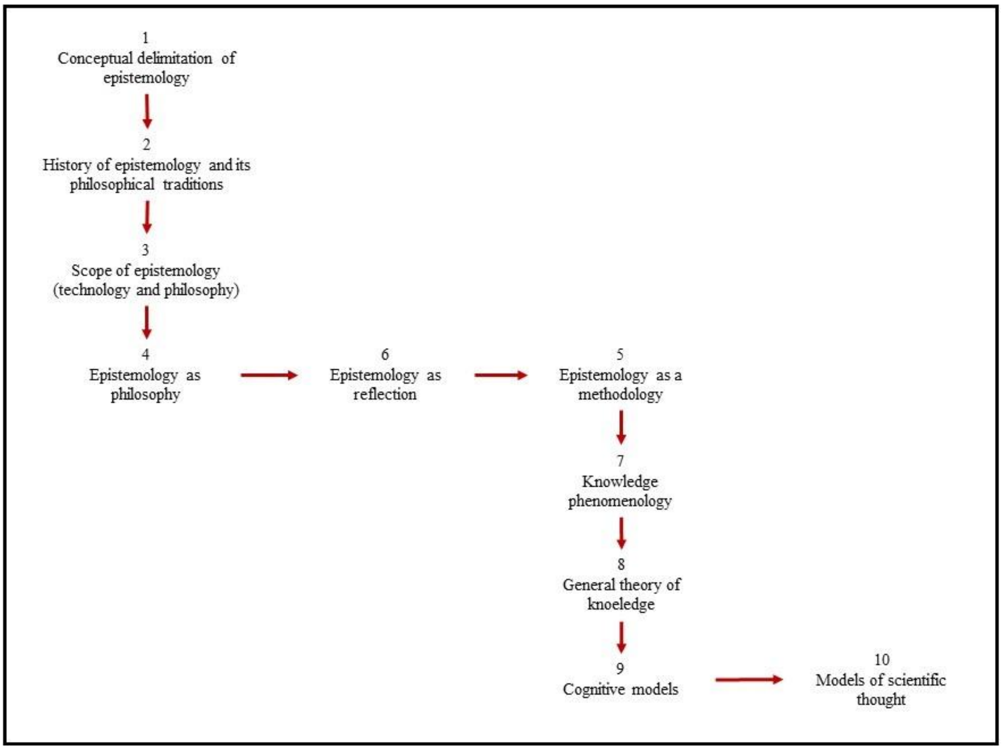


Figure 9: Example of the educational sequence obtained from the graph made with the Morganov-Heredia technique.

In the vertical transfer criterion, the logical sequence recovers the level of generality and relevance of each one of the “information units”. At this point, the number of relationships established between each vertex is analyzed. This number allows determining the importance and / or relevance of the "information unit" in relation to the general structure of the course. For example, the graph shown in figure 8 highlights the importance of the intermediate vertices 5, 6, 9 and 10, due to their number of relationships. Placing them at the level of generalization, the central axis of topics 5 and 6 for the construction of knowledge is shown, due to the fact that they are intermediate vertices. While items 9 and 10 represent edge vertices, which are linked to the objectives of the course. This type of analysis makes it possible to determine their upward progression in the construction of knowledge and student learning.

On the other hand, the horizontal transfer criterion makes it possible to analyze the logical sequence of the information units in terms of simultaneity of the approach of the information units. This is the case for vertices 4, 5, 6, 9, and 10 in the graph in Figure 8. Which vertex should come first? The educational sequence requires the teacher's experience to determine the sequence of these topics according to the learning cycle, starting with basic knowledge, increasing in complexity and abstraction as the course progresses.

The product of the hermeneutic interpretive analysis ends with the structure of the educational sequence (Figure 9), which will base the writing of the didactic guide for the student. It is important to indicate that an auxiliary tool for the analysis in the logical construction of the educational sequence is the application of the triad "reflective practice-theory-practice" linked to the Gadamerian hermeneutical circle (interpretation-understanding-application).

## VIII. Conclusion

Applying the Morganov-Heredia technique to the structural analysis of the educational process is a meticulous task that requires dedicating enough time to complete it. The result obtained, in relation to the time devoted to the activity, is satisfactory, as it allows the logical integration of the units of information analyzed, but also provides scientific evidence of the level of integration of these units.

Understanding the educational process as a phenomenon of a social nature has practical implications that are reflected in the triad “practice-theory-reflective practice” that takes place during the activities carried out by the teacher. To systematize this type of experiences, the Morganov-Heredia technique offers the possibility of leading the teacher along a path that allows him to identify the objectives, competencies, themes, content or learning activities that are accessible and successful.

Among the limitations of the technique, the prior knowledge that the teacher should have in relation to graph theory and matrix algebra is identified. However, the application of this knowledge is basic and it is possible for one to quickly become familiar with the concepts and their applications.

Once its development of the Morganov-Heredia technique has been understood, it is possible to use computer systems to carry out the process of the technique; however, the analysis of the graph obtained is fundamental, which is why the hermeneutical interpretive approach was used in which a virtuous circle is generated when interpreting, understanding and applying.

Finally, it is shown that the Morganov-Heredia technique is a useful tool for the analysis of the teaching activity that allows planning and organizing the courses that are taught, considering the articulation, structuring and organization of the elements in an educational sequence that facilitates both the teaching activities designed by the teacher, such as student learning activities.

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