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*Artículos científicos*

## **Modelo conceptual para diseñar un plan curricular auxiliar sostenible en periodos de contingencia para las instituciones públicas de educación superior**

*Conceptual model to design a sustainable auxiliary curriculum plan in contingency periods for public institutions of higher education*

*Modelo conceitual para elaboração de plano curricular auxiliar sustentável em períodos de contingência para instituições públicas de ensino superior*

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### **Resumen**

El presente trabajo es el resultado del estudio de una herramienta innovadora de diseño curricular para la educación del desarrollo sostenible. El principal objetivo fue crear un instrumento estratégico de gestión para situaciones críticas durante el proceso de enseñanza y aprendizaje. Se analizó el método de diseño curricular de tres instituciones públicas de educación superior, tres postulados internacionales para la educación del desarrollo sostenible, dos teorías de aprendizaje constructivista basado en el andamiaje, una teoría para el diseño de estrategias de aprendizaje, así como referencias acerca de los estilos y modelos de aprendizaje.

El estudio se basó en los métodos analítico, sistémico e inductivo, a través de los cuales se obtuvieron datos acerca del contexto de las principales teorías de aprendizaje constructivista, métodos de diseño curricular, postulados acerca de la educación para el desarrollo sostenible, tendencias tecnológicas en la educación, tipos y modelos de aprendizaje, y formas de enseñanza.



Se observó que ninguno de los métodos utilizados por las tres instituciones públicas de educación superior dispone de un plan de contingencia para situaciones críticas dentro de la estructura del método de diseño curricular, aunque se han implementado acciones para dar solución a los problemas presentados. En cuanto a su estructura, se identificó que el método es diverso, con excepción del modelo curricular, ya que en dos instituciones es sistémico y en una es modular.

Los temas relacionados con la agenda 2030 para el desarrollo sostenible en el contenido curricular de los programas de estudio favorecen la calidad de la educación. Se sugiere integrar en el método de diseño curricular un plan auxiliar sostenible para la prevención de situaciones críticas y también incorporar temas relacionados con el desarrollo sostenible que sirvan de complemento al contenido programático vigente y que propicie el aprendizaje significativo sostenible para dar respuesta a situaciones críticas derivadas de fenómenos naturales ocasionados por el cambio climático.

**Palabras clave:** educación para el desarrollo sostenible, enseñanza superior, innovación educacional, plan de estudios, tendencia educacional.

## Abstract

An innovative curriculum design tool for sustainable development education was obtained as a result of the study. The main objective was to create a strategic management instrument for critical situations during the teaching-learning process.

The curricular design method of three public institutions of higher education, three international postulates for the education of sustainable development, two theories of constructivist learning based on scaffolding, a theory for the design of learning strategies, as well as references about learning styles and models.

The study was based on analytical, systemic and inductive methods, through which data were obtained about the context of the main constructivist learning theories, methods of curriculum design, postulates about education for sustainable development, technological trends in education, the types and models of learning and the forms of teaching.

It was observed that none of the methods used by the three public higher education institutions has a contingency plan for critical situations within the structure of the curriculum design method, however, in the three institutions, actions have been implemented to provide solutions to the critical situations that arise. Regarding its structure,

it was identified that the method is diverse with the exception of the curricular model since in two institutions it is systemic and in one it is modular.

The topics related to the 2030 agenda for sustainable development, in the curricular content of study programs, favor the quality of education. It is suggested to integrate into the curriculum design method a sustainable auxiliary plan for the prevention of critical situations and also to incorporate topics related to sustainable development that serve as a complement to the current program content and that promote sustainable meaningful learning to respond to derived critical situations of natural phenomena caused by climate change.

**Keywords:** education for sustainable development, higher education, educational trend, curriculum, educational innovation.

## Resumo

O presente trabalho é o resultado do estudo de uma ferramenta inovadora de desenho curricular para a educação para o desenvolvimento sustentável. O objetivo principal foi criar um instrumento de gestão estratégica para situações críticas durante o processo de ensino e aprendizagem. O método de concepção curricular de três instituições públicas de ensino superior, três postulados internacionais para a educação para o desenvolvimento sustentável, duas teorias construtivistas de aprendizagem baseadas em andaimes, uma teoria para a concepção de estratégias de aprendizagem, bem como referências sobre estilos e modelos de aprendizagem.

O estudo baseou-se em métodos analíticos, sistêmicos e indutivos, através dos quais foram obtidos dados sobre o contexto das principais teorias construtivistas de aprendizagem, métodos de concepção curricular, postulados sobre educação para o desenvolvimento sustentável, tendências tecnológicas em educação, tipos e modelos de aprendizagem e formas de ensino.

Observou-se que nenhum dos métodos utilizados pelas três instituições públicas de ensino superior possui plano de contingência para situações críticas dentro da estrutura do método de desenho curricular, embora ações tenham sido implementadas para solucionar os problemas apresentados. Quanto à sua estrutura, identificou-se que o método é diverso, com exceção do modelo curricular, visto que em duas instituições é sistêmico e em uma é modular.

Os temas relacionados à agenda 2030 para o desenvolvimento sustentável nos conteúdos curriculares dos programas de estudos favorecem a qualidade da educação. Sugere-se integrar no método de desenho curricular um plano auxiliar sustentável para a prevenção de situações críticas e também incorporar questões relacionadas ao desenvolvimento sustentável que complementem o conteúdo programático atual e que promovam uma aprendizagem significativa e sustentável para responder às situações críticas que surgem de fenômenos naturais causados pelas mudanças climáticas.

**Palavras-chave:** educação para o desenvolvimento sustentável, ensino superior, inovação educacional, currículo, tendência educacional.

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## Introduction

The theoretical and conceptual approach to sustainable development arises when the United Nations Commission on Environment and Development presented in 1987 the Brundtland Report, called Our Common Future. The document contains the concept of sustainable development, which is presented as an alternative to seek progress based on the rational use of natural and human resources. Therefore, it is defined as "one that meets the needs of the present, without compromising the needs of future generations" (United Nations Educational, Scientific and Cultural Organization [Unesco], 2012, p. 5). This term, in other words, is used to refer to the need to make great changes not only in terms of sensitivity to nature, but mainly in national and international production and consumption systems, hence it has served to promote various international debates.

In 2002, for example, the World Summit on Sustainable Development was held, called the Johannesburg Summit, Rio + 10, where the proposal for the United Nations Decade of Education for Sustainable Development was presented, which was approved until 2005. In 2013 Unesco —to follow up on this initiative— presented the global action program on Education for Sustainable Development, and in 2014 —at the World Meeting on Education for All (EFA) - it was incorporated a global goal for 2030. Then, in 2015, the World Education Forum (held in Incheon, Republic of Korea) was held, where six thematic debates were held and an agreement was generated to unite the educational community in a common vision through the educational agenda 2015-2030 (Unesco, 2017).

Likewise, the United Nations Summit on Sustainable Development was also held in 2015, where one hundred and ninety-three member states approved the agenda for sustainable development, which was reflected in the document called Transforming our world: the 2030 agenda. for sustainable development (United Nations [UN], 2015, p. 1). This included seventeen goals for sustainable development, of which number 4 focused on quality education to improve life on the planet through sustainable development. Based on this vision, the current situation with the pandemic in the world acquires greater relevance. In this regard, the World Health Organization (WHO) has stated that “the urgent measures adopted by cities and other urban settlements in relation to COVID-19, must lay the foundations for sustainable development, of the capacity to face emergencies of simultaneous or future health ”(WHO, 2020, p. 10).

In this context, strategies such as hybrid learning (or b-learning) are becoming more and more relevant, which is based on a model that arises in the business environment, and which is supported by eclectic and practical thinking (Bartolomé and Aiello, 2006). Salinas, De Benito, Pérez and Gisbert (2018) report that this methodology combines face-to-face teaching strategies with the use of technology to improve and reinforce the learning experience through different models, such as those explained below:

- **Rotation model:** It consists of rotating the learning modality through different approaches: flipped classroom, classroom and online learning, in the laboratory or individual.
- **Flexible model:** It is the combination of face-to-face and online modality; It is used for the development of projects or tutorials.
- **A la carte model:** In this the student has the option of registering a percentage of subjects online and another in person.
- **Enriched virtual model:** It facilitates the student to take most of the online course outside the institution; In addition, she attends a face-to-face class with a tutor to provide feedback on learning.

## Framework

Talking about the impact that covid-19 has on education for sustainable development means that the international programs proposed to promote the transformation of education by 2030 require a cause and effect analysis about the current context generated

by the pandemic, since In this way, the starting point after confinement can be known, as well as the opportunities to improve education for sustainable development proposed in 2015.

According to the figures provided in the month of March 2020 in the monitoring of the global follow-up of school closings caused by Covid-19 of the UNESCO World Coalition for Education, the confinement “affected the education of more than 1500 million students worldwide in 185 countries that have closed schools and universities throughout the territory, which affected 89.4% of the student population on the planet ”(para. 3). Consequently, Unesco has promoted actions to mitigate the impact, mainly in the most vulnerable communities to facilitate the continuity of education through remote learning. In the case of Mexico, a special program was implemented for all elementary-level students called Aprende en casa por TV. In addition, public and private educational institutions have developed their own online learning strategies through the use of various platforms, as well as digital and electronic tools to promote meaningful learning in students.

On the other hand, the National Institute of Statistics and Geography (Inegi) (2019), in the National Survey on Availability and Use of Information Technologies in Homes, has indicated that in Mexico there are 80.6 million Internet users, which it represents 70.1% of the population six years of age or older. It is also estimated that 20.1 million households have internet, which constitutes 56.4% of the general total. The main means of internet connection are smartphones (95.3%), laptop (33.3%) and desktop computer (28.9%). The proportion of cell phone users in urban areas is 72.4%. In addition, 92.5% of households have a television, of which 96% have a digital pay signal or decoder, and 4% do not have a digital signal.

On the other hand, it is worth noting that the aforementioned World Forum on Education held in Incheon (Republic of Korea) established the Education 2030 Framework for Action, in which eleven global indicators were proposed that interact with thematic, regional and national indicators. in order to promote sustainable development, entrepreneurship and decent employment.

## Problem Statement

Understanding the sustainable development model to try to transform people's lifestyles requires the conceptualization and interaction of economic, social and environmental factors to build a better future. This requires incorporating a new tradition of life at a global level towards progress, through the rational use of natural and human resources, as well as making major changes that promote sensitivity to nature to transform production and consumption systems with participation active of society in general.

So far, more than three decades have passed from the conceptual approach to sustainable development embodied in the Brundtland Report; However, the interaction of development with the environment has not been achieved, two components that should form a mesh to achieve a better quality in the living environment. For this reason, it has been observed that over time critical situations have been generated related to social inequality, poverty, health problems, loss of natural and human resources, as well as environmental degradation, among others.

Currently, a critical situation that is experienced globally in the educational system is related to covid-19, which has led to the confinement of people. This health problem has generated a great crisis in education due to the lack of a culture of contingency planning with auxiliary curricular plans. It is also inferred that social interaction through digital media has impacted the most vulnerable population as a result of the digital divide, which could have an impact on meaningful learning at all educational levels, as well as the lack of training to develop digital skills both teachers and students incorporated in schooled higher education.

Another situation to consider until the reopening of the schools will be to give priority to health, for which the educational actors will have to establish new roles to promote knowledge by becoming aware of the current reality. This is how learning plays an important role in both formal and non-formal and informal education. In short, it is necessary to identify the importance of education as a key element in raising awareness and training to achieve sustainable development, as stated at the Rio Summit in 1992. Even so, a diversity of interpretations related to education for sustainable development, which affects the achievement of the transformation of learning, as well as the evolution of fairer societies with new sustainable lifestyles.

Therefore, the relevance of this research lies in generating new lines of research and analyzing the meaning of curricular design methods, because in this way it is possible to work on innovating and increasing the quality of education through the creation of new tools curricula focused on strengthening the content of the study programs with topics related to sustainable development and incorporating didactic sensory strategies that combine techniques with digital applications and electronic media. Likewise, provide the opportunity to expand the knowledge derived from the new challenges in the creation, design or curricular redesign of the study programs of public institutions of higher education, since at present research to evaluate the implementation of plans is incipient. auxiliaries that are part of the curricular design method of the educational offer.

### **Purpose of the investigation**

Analyze the meaning of curricular design methods and identify areas of opportunity to mitigate the effects of confinement in the curricular plan of the school modality in order to promote the continuity of education for sustainable development from the stage of return to school. schools with new forms of interaction in the teaching and learning process. Likewise, to provide a strategic management tool for critical situations derived from incidents that could temporarily or permanently stop the learning process and create a sustainable auxiliary curricular design plan that includes strategies through hybrid learning for critical contingency situations and contents related to education for sustainable development in all areas of knowledge. In this way, it seeks to contribute to the transformation of the teaching competencies and learning skills of the student in a resilient and open way to change, as well as in the actions of the 2030 agenda for education for sustainable development.

### **Hypothesis**

It is inferred that the curriculum design method of the school model of public higher education institutions does not guarantee that the program content achieves the objectives for the development of competencies and skills in students in critical situations that lead to the closure of schools, since that only the use of electronic and digital tools is implemented in an alternative and provisional way to give continuity to the learning process.



Currently, covid-19 is a pandemic that affects most of the countries in the world. The virus has led to the confinement of people worldwide, which has forced us to seek other forms of interaction. This has impacted all sectors, especially education, hence the following questions have been raised:

What are the innovations that would favor education for sustainable development and thereby increase the quality of education?

What is the importance of incorporating within the structure of the curriculum design method a sustainable auxiliary plan, which includes didactic strategies for critical situations that prevent continuity in the teaching and learning process in the classroom?

This seeks to understand the importance of conducting a qualitative study to design a tool that integrates a sustainable auxiliary curricular plan with strategies, types and models of learning for moments of contingency derived from critical situations that prevent continuity in the process of teaching and learning in the classroom.

In addition, it seeks to incorporate into the structure of the curriculum design method an auxiliary plan that includes content related to education for sustainable development, as well as didactic strategies to promote the training of both teachers and students for the education of the future.

## Method

The study was based on analytical, systemic and inductive methods, through which data were obtained about the context of the main constructivist learning theories, curricular design methods, postulates on education for sustainable development, technological trends in the education, types and models of learning and forms of teaching.

The information was analyzed, coded and categorized in a relational database management software. The tool recorded the characteristics, components, methods, theories, trends, types, styles and learning models related to the research context. Then, with the data, a comparison was made and the interactions were defined through a context and relationship diagram.

## Sample

During the qualitative research process, first a sample was made to take a representative part of the population, such is the case of a curriculum design method of three public institutions of higher education, three international postulates for sustainable development education, two scaffolding-based constructivist learning theories, a theory for the design of learning strategies, as well as references about learning styles and models.

The sample population was determined based on the characteristics of the online resources located on the websites of public institutions of higher education, as well as international organizations. In turn, to calculate the sample, the non-probabilistic technique was implemented for convenience (McMillan and Schumacher, 2005), taking into account that the data were obtained from primary documents available in various digital media of public access, which facilitated the development Of the investigation.

Later, as the analysis continued, the location of the primary documents was identified; later it was agreed to review the available information in order to select the useful data for the investigation. The target population was delimited by identifying the affordable population. Consequently, to integrate the basic units of analysis, the corrections made to the initial sample were developed as the information was collected and organized.

## Instruments

The Microsoft Access 2016 software was used for the management of relational databases. In this way, it was possible to organize, order, group and classify the data obtained in the primary information sources in a simple and intuitive way without requiring a developer. With this program you can export or convert the information in various electronic formats (PDF, Excel or SQL). In addition, it allows you to store, search, manage and share data, as well as analyze and print information. The database is made up of tables that are assigned a primary key that establishes the conditions of use to guarantee their validity and referential integrity in the interaction between them, which avoids deleting, modifying or duplicating the data.

### **Validity**

A computer tool was designed to store the information analyzed in the primary documents. The design of the database is supported by the validity of the construct where each of the fields created corresponds to the codes, categories and subcategories of the variables of the basic units of analysis, generated from the curriculum design methods, scaffolding theories, international postulates of education for sustainable development, referents of strategies, types, styles and models of learning.

### **Reliability**

The quality and updating of the content of the information from primary sources supports the prestige of the data published on the websites of public higher education institutions, as well as international organizations.

### **Objectivity**

The content of the database is reliable due to its ontological nature, since the data was recorded with the literal language obtained from the primary information sources. This is how the categories and subcategories of the variables are epistemologically supported, since they are based on the conceptualization of higher-level educational institutions, as well as international organizations. Consequently, the research has an ethical character, based on impartiality because the purpose of the study is focused on providing scientific knowledge.

### **Process**

To collect information, the method of collecting documents and materials was used, as well as the technique of analyzing the content of documents, records, materials and artifacts, so the participation of interviewers and the request for permits to apply an instrument due to because there is a great diversity of primary documents of public access.

To continue with the data collection, an information search process was designed to organize and interpret it. This consisted of searching the collection of public institutions of higher education, as well as international organizations related to education programs for

sustainable development. Trends and external factors that could influence the axis of research in various primary information sources were also analyzed.

The information was organized in a systemic way, through the interactions between the codes of the basic analysis units, as well as the variables, categories and subcategories identified in the data of the population under study. In addition, when performing the information analysis, new fields were created that had not been considered in the original database.

### **Plan for data collection**

To collect the data, a detailed plan was carried out consisting of processes that facilitated the way of conducting the collection of information. Before analyzing the data, new proposals were added to the hypothesis: what is the method of curriculum design used in public institutions of higher education? What are their characteristics? What mechanisms do they incorporate in the curriculum design method for critical situations? What are the innovations incorporated in the curriculum design method with respect to the trends in education at the international level? What are the postulates of international organizations related to education for sustainable development? What are the postulates that affect education for sustainable development? What precursors bring the scaffolding theory? How is scaffolding applied in the curriculum design method? What is the focus of each pioneer? What is the impact of covid-19 on education? What is the role of educational institutions when faced with confinement by covid-19? How did the learning process continue during confinement? What is the didactic strategy applied through digital and electronic media? What are their characteristics? What styles and types of learning do they use?

In addition, during the data collection process, the primary information sources were identified in the collection of the websites of public higher education institutions, as well as in the international organizations under study. When conducting the searches, the electronic addresses were recorded where the documents were retrieved and stored in an electronic folder to record the information in the database.

On the other hand, at the conclusion of the information registration, the tools available in the database management software were used to generate reports, which display a matrix that shows the interaction of the twenty-two variables with the one hundred and thirty-eight

categories identified. to be analyzed and interpreted. The database's referential integrity tool was also used to map the basic units of analysis to highlight representative research data.

Regarding the description of the database design, first twenty-two tables were created that represent the variables of the basic units of analysis under study, which contain fields that are part of the categories of recording and information storage. Subsequently, twenty-two queries representing the codes of the basic units of analysis were generated with the tables; Its function is to retrieve specific data from the tables when searching within the database.

Then three forms were designed that represent the graphical environment of access to the database; its interface contains command buttons to add a new record, delete it, close the form, print table and exit.

Three reports were also created that display the information in the form of a matrix with the corresponding interactions between variables and categories. The information may be exported to other word processing software, spreadsheets or sending electronic messages. Finally, three macros were created to add functions such as generating a portable content format (PDF) or importing the database into a structured query language (SQL).

Regarding the coding of the data, it was carried out through a systemic process where codes were assigned to both the variables and the categories that make up the database, which facilitated the analysis, the conceptualization of the information, as well as the interaction of the data, as shown in Table 1.

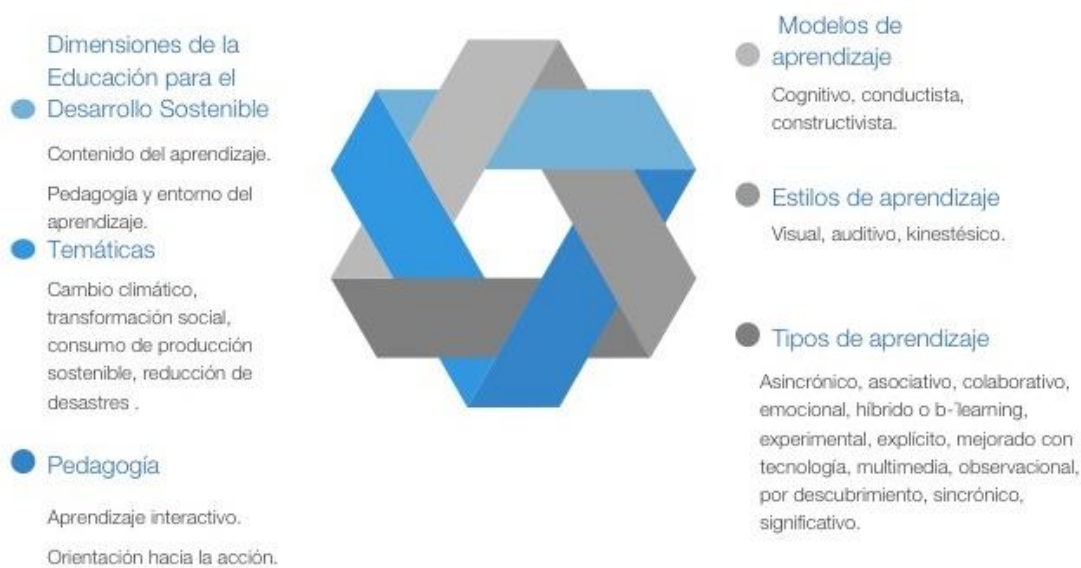
**Tabla1.** Codificación de variables y categorías que conforman la base de datos

Código y nombre de la variable	N.º campos	Categorías
I. Referencia del método de diseño curricular	3	Estructura, lineamientos, metodología.
II. Institución	3	UNAM, UAM, IPN.
III. Vigencia del método curricular	4	Actualizado, nuevo, vigente.
IV. Fundamento de la estructura del método curricular	5	Propósito, normatividad.
V. Estructura del método curricular	3	Anteproyecto, propuesta.
VI. Componentes de la estructura del método curricular	3	Análisis de pertinencia, marco legal.
VII. Tipo de método curricular	3	Sistémico, modular, marco normativo.
VIII. Características del modelo curricular sistémico	1	Basado en procesos.
IX. Características del modelo curricular modular	1	Estructuras cognitivas.
X. Dimensiones de la educación para el desarrollo sostenible	4	Contenido de aprendizaje, pedagogía.
XI. Temáticas adicionales a incorporar en contenido	7	Cambio climático, consumo y producción sostenible.
XII. Pedagogía para el aprendizaje interactivo	3	Aprendizaje orientado hacia la acción.
XIII. Contribución de la Unesco	9	Interacción con objetivos de desarrollo sostenible
XIV. Interacción de objetivo 4.	10	Objetivos 1, 3, 5, 8, 10, 11, 12, 13, 15, 16 y 17
XV. Interacción de objetivos 6, 9, 11, 13 y 15	12	Objetivos 1 al 5, 7, 8, 10, 12, 14, 16 y 17
XVI. Interacción de objetivo 14	13	Objetivos 1 al 5, 8 al 13, 15 y 17
XVII. Interacción de objetivos 11 y 16	7	Objetivos 1, 3 al 5, 10, 13 y 17
XVIII. Interacción de objetivo 11 y 16	13	Objetivos 1 al 6, 8, 10, 12 al 15 y 17
XIX. Interacción de objetivo 4, 9 y 16	8	Objetivos 1, 5, 6, 8, 10, 11, 13 y 17
XX. Tipos de aprendizaje	20	Asincrónico, híbrido o <i>b-learning</i> , entre otros.
XXI. Estilos de aprendizaje	3	Auditivo, kinestésico, visual.
XXII. Modelos de aprendizaje	3	Cognitivo, conductista, constructivista.

Fuente: Elaboración propia

On the other hand, the categories related to curricular design, as well as the types, styles and learning models incorporated in table 1 are part of the innovation proposal for the design of the auxiliary curricular plan, where the category dimensions of education for sustainable development, as well as themes and pedagogy were adapted from Unesco (2014, pp. 11-12), as shown in figure 1:

**Figura 1.** Categorías que conforman el método de diseño curricular innovador dentro de la base de datos



Fuente: Elaboración propia diseñada en Infographics templates for PPT (versión 1.2.3)

## Results

The research was based on the qualitative method for social change, as it is an approach to educational theory that contributes to a social analysis. It was also based on the epistemological model of symbolic interactionism (Hernández, Fernández & Baptista, 2014). Likewise, the study relied on analytical, systemic and inductive methods, which facilitated the formulation of the hypothesis and the creation of codes, categories and subcategories with which the interactions of the variables generated in the basic units of analysis were identified. to examine the data obtained through the information sources described above.

On the other hand, the fundamental basis of the analysis of results was based on the context and relationship of the data. The graphical representation of figure 2 shows in a general way the interaction of the basic units of analysis with respect to the categories and subcategories of the data under study. In the center of the diagram is the entire system represented by the components of the research context, which are connected and differentiated between the factors that add value or are part of the information flow through the relationship that the data within the system, its context and its environment. This is how the basic units of analysis provide value for the analysis of data, based on the objectives and the approach of the research problem. Also the method and process of data collection interact through the flow of information.

On the other hand, the graphic representation of each component of the diagram represented in a specific way with the rectangle located on the left side contains the data that generate inputs, which add value to the components of the rectangle on the right side that represent the elements that make up the categories of the data for the analysis of information and also add value according to the interactions that occur through the flow of information used for the analysis of results. The central graphic representation contains the research process where it is highlighted that the objectives and the problem statement add value to the results analysis process as they are part of the qualitative research method, as well as the data collection process through which the information flows. information. The solid arrows represent the contribution of value in each of the elements that interact in the diagram and the dotted arrows symbolize the flow of information in each interaction.



Figura 2. Diagrama de contexto y relación de la investigación objeto de estudio



Fuente. Elaboración propia diseñada en Infographics templates for PPT (versión 1.2.3) con imágenes Google

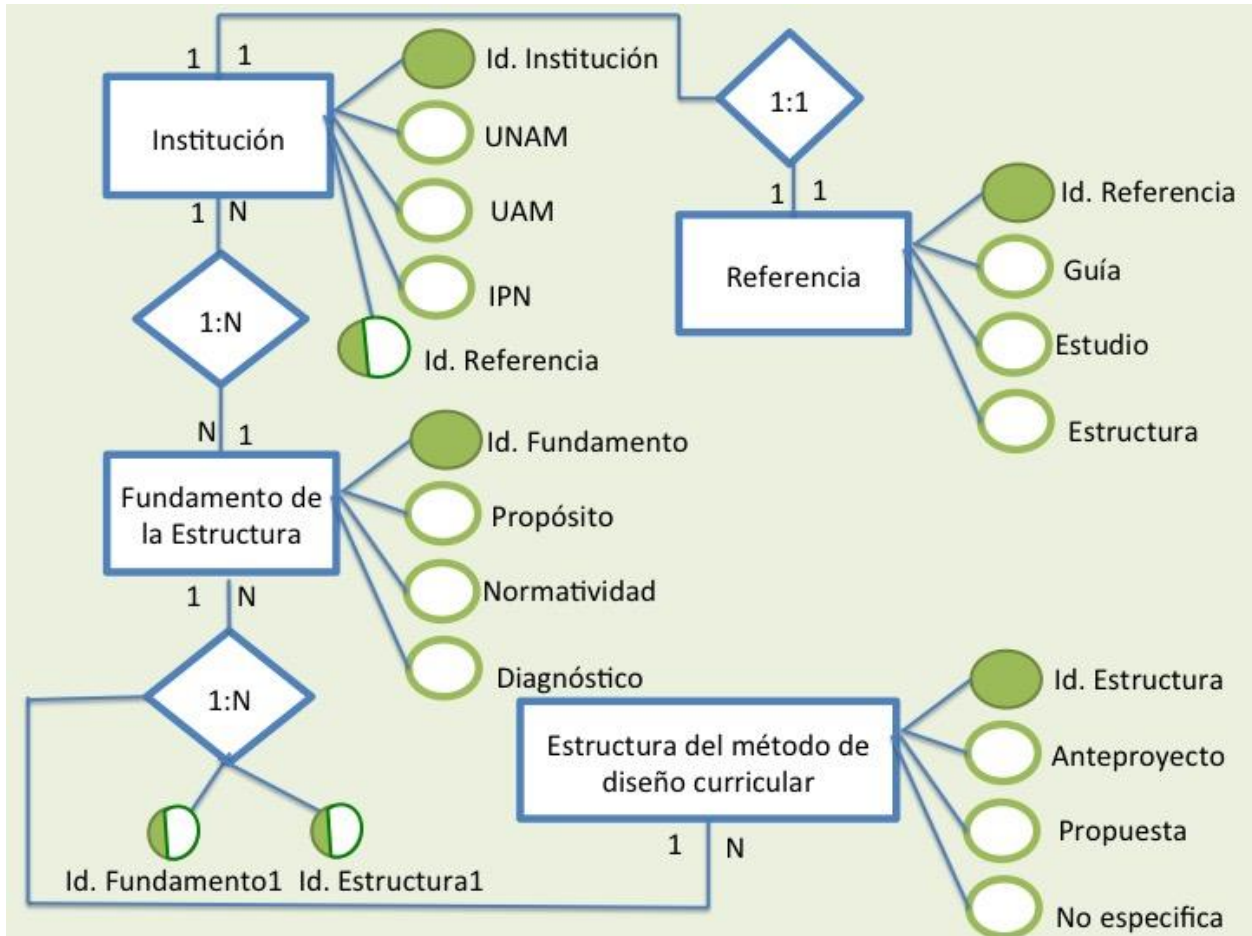
Regarding the methodological rigor of the results obtained in the research, it is highlighted that they were of an ontological and ethical nature based on the impartiality and objectivity of the study, as mentioned previously.

On the other hand, during the analysis of the research, the grounded theory was addressed (Hernández et al., 2014), with a systemic nature due to the fact that various categories were identified when comparing the data related to the curriculum design method, some educational theories, the objectives for sustainable development, as well as the 2030 agenda for sustainable development, according to the methods and theories that support each postulate. The interactions are also based on a symbolic interactionism approach derived from the diversity of interpretations identified in the sources of information consulted.

The analysis started from the coding in the database where the interactions were identified. The semantics used both basic units of analysis and in the categories favored the interpretation of the data because they were organized in a systemic way. Figures 3 to 5 show the interaction of the basic units of analysis with respect to the objectives, hypotheses and formulated approaches.

The first data interaction corresponds to the approaches formulated according to the curricular design method, its characteristics and mechanisms used for critical situations. It was observed that none of the methods used by the three public institutions of higher education under study includes a contingency plan to make the pertinent adjustments in the event of a critical situation that prevents the continuity of the study program temporarily or permanently. Regarding its structure, it was identified that the method is diverse, with the exception of the curricular model, since in two institutions it is systemic and in one it is modular. In the case of the National Autonomous University of Mexico, its methodology is based on a preliminary project that applies the scientific research method (Universidad Nacional Autónoma de México, 2017, pp. 9-11). In the National Polytechnic Institute, the foundation corresponds to institutional guidelines (National Polytechnic Institute, 2012, pp. 3-8) and in the Metropolitan Autonomous University the adjective it assigns to refer to its method is unknown because it is called structure; However, it takes into account the operational policies, processes and the educational model of the institution (Universidad Autónoma Metropolitana, 2005, pp. 63-76), as shown in figure 3:

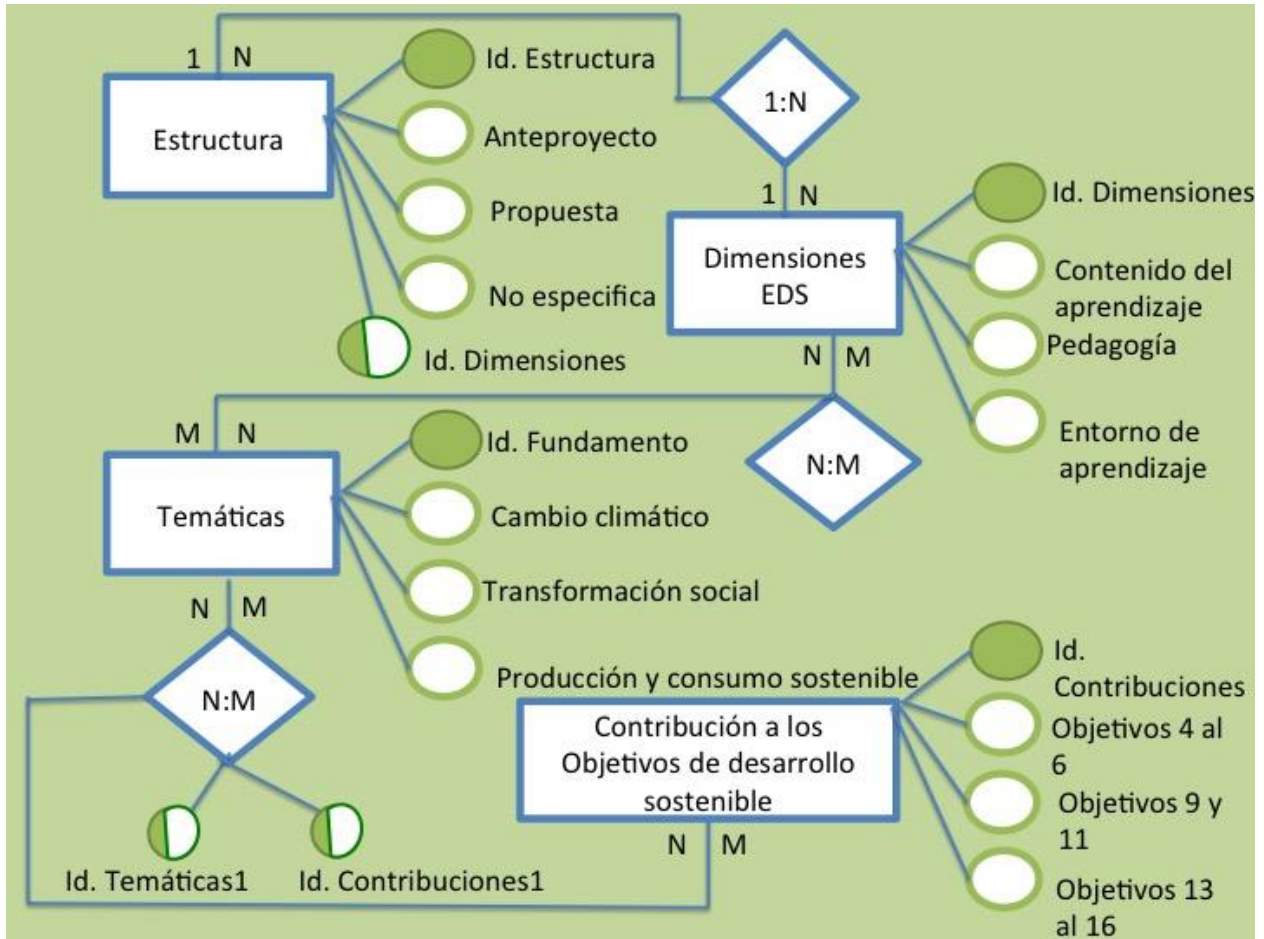
**Figura 3.** Diagrama de entidad relación respecto a la estructura y fundamento del método de diseño curricular



Fuente: Elaboración propia diseñada en Diagrammix (versión 2.16)

It corresponds to the second interaction to address the contributions of international organizations. It is inferred that —due to the date of elaboration of the curriculum design method in the three public institutions of higher education— they lack specific sections to address issues about education for sustainable development and an auxiliary plan for contingencies; however, they have alternative programs to incorporate aspects related to sustainability, but separate from the structure of the curriculum design. Consequently, the database generated interaction with the dimensions of the 2030 agenda for education for sustainable development of Unesco, which addresses aspects related to pedagogy, learning environments, as well as themes that interact with the objectives of sustainable development postulated by the UN, as shown in figure 4:

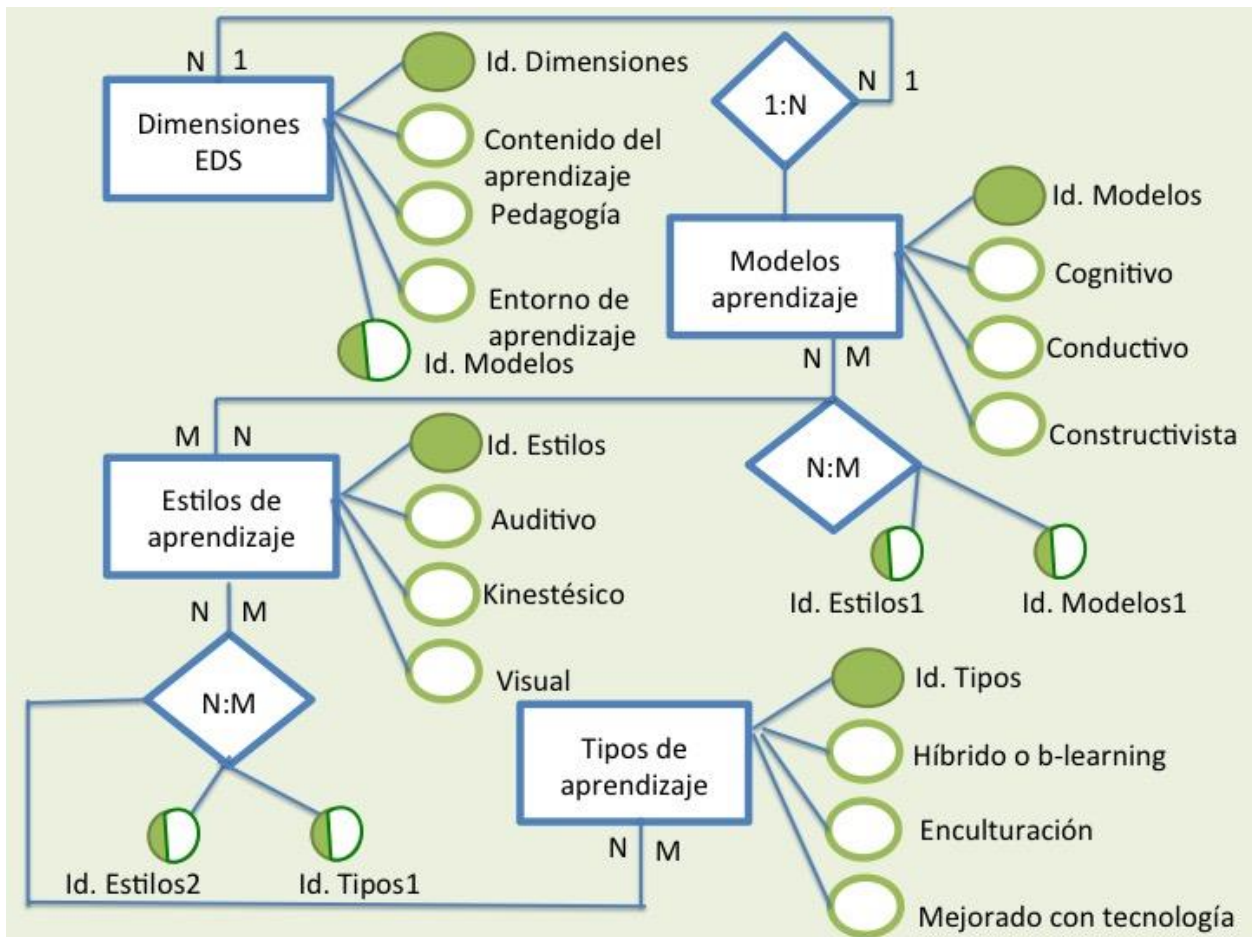
**Figura 4.** Diagrama de entidad relación respecto a las dimensiones y temáticas de la educación para el desarrollo sostenible



Fuente: Elaboración propia diseñada en Diagrammix (versión 2.16)

Finally, the third interaction corresponds to the dimensions of education for sustainable development regarding the models, styles and types of learning, which will serve as a complement to be considered in the modality section of the curricular proposal, as shown in the figure 5:

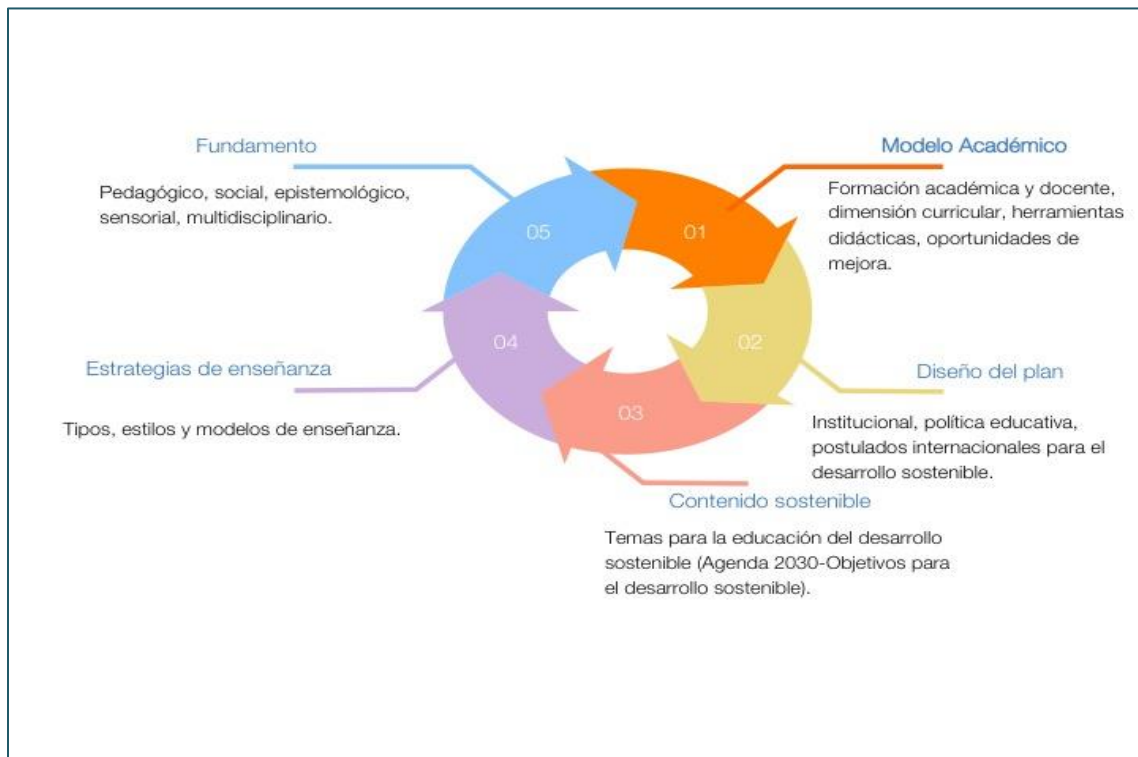
**Figura 5.** Diagrama de entidad relación respecto a la interacción de las dimensiones de la educación del desarrollo sostenible en relación con las modelos, estilos y ambientes de aprendizaje



Fuente: Elaboración propia diseñada en Diagrammix (versión 2.16)

It should also be mentioned that as a result of the research, an innovative systemic tool is proposed to support the work carried out in the curricular design of public higher education institutions. The tool is called the Conceptual Model of the Sustainable Auxiliary Curriculum Plan in Contingency Periods for Public Higher Education Institutions. The structure of the model is constituted by the interaction of five phases, as shown in figure 6:

**Figura 6.** Modelo conceptual del plan curricular auxiliar sostenible



Fuente: Elaboración propia diseñada en Infographics templates for PPT (versión 1.2.3)

### Phase 1. Academic model

This proposes to retake substantive aspects, such is the case of the student's academic training (it is considered to include the knowledge, competencies and skills expected during their training). Regarding teacher training, it contemplates implementing training actions to strengthen their skills and identify their professional and didactic experience. Factors related to education for sustainable development are included in the curricular dimension to strengthen inclusive quality education. In the didactic tools it is intended to potentiate the digital tools to make the classes more dynamic. Finally, in opportunities for improvement, an attempt is made to identify the strengths and weaknesses of the teaching and learning process in order to optimize it permanently.

## **Phase 2. Plan design**

Data related to the institution, the policies of the education sector and the postulates of international organizations on education for sustainable development will be taken as a background for the development of the contents.

## **Phase 3. Sustainable content**

It corresponds to the phase to interact with the academic program in all the subjects that comprise it; It is intended to add topics considered in the 2030 agenda for sustainable development.

## **Phase 4. Teaching strategies**

It establishes the incorporation of auditory, kinesthetic and visual learning styles in the strategies, as well as the diversity of learning styles to favor the use of didactic tools according to the interaction of the learning model to be implemented.

## **Phase 5. Rationale**

It consists of supporting teaching strategies with a social, pedagogical, epistemological and multidisciplinary foundation.

## **Discussion**

At the end of the research, a data bank was obtained as a result that contains information related to the context of the design of the curricular method, as well as the factors that interact with education for sustainable development and with the types, styles and models of learning. In addition, a model was designed to create a sustainable auxiliary plan in contingency periods.

The findings identified represent an opportunity to adopt new innovative tools in the curricular design methods of public higher education institutions, as well as to generate new lines of research with the following approaches:

- The use of information technology (ICT) to reinforce individualized learning.
- Teacher training activities to strengthen the use of hybrid learning methods and tools or b-learning.

- Didactic strategies for the design of educational content for sustainable development in a hybrid model.

On the other hand, Reimers and Schleicher (2020) presented a report produced by the Global Educational Innovation Initiative of the Harvard Graduate School of Education in collaboration with the Directorate of Education and Skills of the Organization for Economic Cooperation and Development (OECD). The report has the purpose of supporting the decision of the leaders of the educational systems to implement plans with alternative modalities derived from social isolation due to the covid-19 pandemic, "based on the analysis of data from the most recent survey applied with PISA" which assesses the educational challenges created in this context. In this regard, aspects are specified to avoid learning loss, as well as prioritizing curricular objectives to define what should be learned during confinement. They also share a "flexible plan for continuity of instruction" where two scenarios are formulated for teaching, through the hybrid or mixed model. The proposal considers giving classes in person and online to a specific number of students in each modality. For this, the teacher must previously plan the classes, the materials, as well as the didactic strategies and evaluations, in addition to coordinating the classes in both modalities.

They also report that the OECD's Program for International Student Assessment (PISA) 2018 shows that on average "9% of 15-year-old students do not even have a quiet place to study at home. Online learning requires not only a place to study, but also a computer that students can use to work at home." (p. 15).

Likewise, Sanz et al. (2020) warn in the "report on the effects of the coronavirus on education", which is part of the initiative of the Organization of Ibero-American States for Education, Science and Culture (OEI) regarding the fundamental role of parents to support students at home, which will also depend on the quality of the digital platform. These authors point out that the key to success will be "teacher training in the use of online methodologies and their interaction in learning" (p. 10).

The document also points out the impact of the closure of the learning centers with respect to the adjustments that could be made in the contents of the curriculum, which would generate an increase in the knowledge gap.

The first two approaches to the hypothesis made it possible to structure the referential database. By continuing with the research process in the data collection phase, new



approaches were formulated with the findings found, for which they were grouped to respond to the aspects related to the method of curriculum design, postulates about education for development sustainable, critical situations, as well as learning strategies, which facilitated the design of the proposed model.

Finally, something that could limit the application or implementation of the instruments generated in the research would be the diversity of perceptions and interpretations of the postulates incorporated in the research.

## Conclusion

Based on the results of the research, it is concluded that public institutions of higher education must permanently innovate in terms of the curriculum design method and incorporate auxiliary tools in critical situations, which serve as a complement to the work carried out in updating or redesigning curriculum in order to give continuity to the teaching and learning process in a sustainable way.

Likewise, incorporating topics related to the 2030 agenda for sustainable development in a sustainable auxiliary curricular plan in a multidisciplinary way favors the quality of the training of students, as well as meaningful learning by applying knowledge in the prevention of critical situations derived from phenomena caused by climate change, which promotes the prosperity and well-being of society in general, as well as the protection of the environment.

On the other hand, so far the hypothesis raised regarding the "curriculum design method does not guarantee that the program content will achieve the objectives for the development of competencies and abilities of the students." It has not been possible to confirm or reject because the public institutions of higher education under study are in the process of implementing the evaluation and diagnosis of the knowledge acquired through the didactic strategies and technological tools used during the confinement process derived from the covid-19 pandemic.

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