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Estrategia didáctica para la construcción de un modelo de datos

Didactic Strategy for the Construction of a Data Model

Estratégia didática para a construção de um modelo de dados

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Resumen

En el presente artículo se describe una estrategia didáctica que contempla la realidad del estudiante para trabajar el tema de modelado de datos, el cual forma parte de la materia Base de Datos que se imparte en el Centro de Estudios Científicos y Tecnológicos (CECyT) 9, perteneciente al Instituto Politécnico Nacional (IPN). En el grupo experimental se aplicó una estrategia didáctica basada en la experimentación y la practicidad de la teoría constructivista; en el grupo de control se trabajó el tema de forma tradicional. Como parte de los instrumentos metodológicos, se empleó la observación y el cuestionario. La primera se llevó a cabo antes de trabajar con el tema y el cuestionario fue utilizado para evaluar la propuesta. Se analizaron los resultados y se observó que el grupo experimental obtuvo mejores resultados que el grupo control. Se concluyó que el uso de la estrategia didáctica trabajada con el grupo de estudio permitió que los estudiantes tuvieran un mejor desempeño en el tema de modelado de datos.

Palabras clave: base de datos, modelado de datos, modelo entidad-relación, normalización.

Abstract

This article describes a didactic strategy that contemplates the student's reality to work on the topic of data modeling, which is part of the subject Database taught at the Centro de Estudios Científicos y Tecnológicos (CECyT) 9, belonging to the Instituto Politécnico Nacional (IPN). In the experimental group, a didactic strategy based on experimentation and the practicality of the constructivist theory was applied; in the control group, the subject was worked on in a traditional way. As part of the methodological instruments, observation and a questionnaire were used. The former was carried out before working with the topic and the questionnaire was used to evaluate the proposal. The results were analyzed, and it was observed that the experimental group obtained better results than the control group. It was concluded that the use of the didactic strategy worked with the study group allowed the students to have a better performance in the topic of data modeling.

Keywords: database, modeling, relationship entity model, standardization.

Resumo

Este artigo descreve uma estratégia didática que contempla a realidade do aluno para trabalhar a disciplina de modelagem de dados, que faz parte da disciplina de Banco de Dados que é ministrada no Centro de Estudos Científicos e Tecnológicos (CECyT) 9, pertencente ao Instituto Politécnico Nacional Instituto (IPN). No grupo experimental, foi aplicada uma estratégia didática baseada na experimentação e na praticidade da teoria construtivista; No grupo controle, o assunto foi trabalhado de forma tradicional. Como parte dos instrumentos metodológicos, foram utilizados a observação e o questionário. A primeira foi realizada antes do trabalho sobre o tema e o questionário foi utilizado para avaliar a proposta. Os resultados foram analisados e observou-se que o grupo experimental obteve melhores resultados que o grupo controle. Concluiu-se que a utilização da estratégia didática trabalhada com o grupo de estudo permitiu que os alunos tivessem um melhor desempenho na disciplina de modelagem de dados.

Palavras-chave: banco de dados, modelagem de dados, modelo entidade-relacionamento, normalização.

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Introduction

Today, databases are widely used as they provide an efficient way to manage information. Its design and use are not a trivial task, since it must be possible to generate a structure such that it does not give rise to redundancy and inconsistency of the data that is handled. This situation has been addressed for several decades, defining schemes and models according to the technological resources and the needs of the time.

In the Programming Technician career of the Center for Scientific and Technological Studies (CECyT) 9 Juan de Dios Bátiz, belonging to the National Polytechnic Institute (IPN), the learning unit called Database is taught, among whose contents is the topic data modeling, a topic that is required for the construction of systems in the area of information technology (IT). Established in study plans and programs, as well as in books dedicated to the subject (Silberschatz, Korth and Sudarshan, 2002, 2011), and according to Rubio (2017), the following teaching sequence is used, to which We call it in this work as traditional teaching sequence:

a) The concepts of database, modeling, types of models, elements that make up both the relational model and the entity-relationship model (E/R) and normal forms are theoretically addressed.

b) A case is presented and analyzed by the teacher.

c) The generation of the model is done.

d) Normal forms are applied to the model.

Said sequence is the traditional way as it is taught under the guidance of the teacher through a project of a concrete database system (Zhuoyi, Na and Hongjie, 2012). Given that the result of this teaching sequence is not measurable during the phases of the process, that is, it is not easy to assess whether the resulting design contains redundancy or inconsistency of data until the designer has managed to generate a model, a didactic strategy is proposed. where it is possible to provide feedback during each phase to the students who are starting the process, which is extremely important since they usually have deficiencies from the choice of attributes and establishment of relationships to the application of normal forms.

Theoretical-conceptual framework

Database

A database is defined as a collection or repository of integrated data, stored on secondary (non-volatile) support and with controlled redundancy. Data that is to be shared by different users across applications must be kept independent of both the users themselves and their applications. The structure of a database is supported by a data model, which should allow capturing the interrelationships and restrictions existing in the real world (Cattell et al., 1997; Miguel and Piattini, 1999).

The use of databases developed out of the need to store large amounts of information. In the 1970s, Codd (1970) published the relational model, as well as a series of rules and norms that, with the development of the E/R model (Chen, 1976), are still used in database modeling. to this day (Beynon-Davies, 2018; Pisco et al., 2017). Currently, there are also approaches: organizational, distributed and object-oriented (Khoshafian, 1993) and NoSQL (Castelltort and Laurent, 2013).

The architecture of a database is defined in three levels: physical, logical and view (Silberschatz et al., 2011). The definition of the database structure is done at the logical level and the tool to represent the structure of a database is the model.

Models

A model is defined as a "set of well-defined concepts, rules and conventions that allow us to apply a series of abstractions in order to describe and manipulate the data of a certain real world that we want to store in the database" (Miguel and Piattini , 1999).

Data models, therefore, are a collection of conceptual tools to describe data, relationships between them, semantics, and consistency constraints (Arora, 2015). Throughout the development of theories about databases, as well as from the technological evolution of physical information stores, various modeling schemes were designed.

Types of modeling

Information management involves proper structuring of it. The first models that were developed were the network and the hierarchical, through which the data was structured as lists and trees; Subsequently, given the advances in information management, both the relational model (E/R) and the object-oriented model were designed, which have been the most widely used (Rashid and Al-Radhy, 2014), Therefore, the didactic strategy proposed in this document is based on their use and they are described in more detail below.

Relational model

A group of tables is used to represent the data and the relationships between them (Silberschatz et al., 2011). It is based on mathematical foundations, which provides efficiency to the operations performed on relations.

Terminology

- *Tuple: set of values that make up a row of a relation.*
- *Domain: set of possible values for a column.*
- *n-tuple: tuple composed of n domains, where n is the degree of the relationship.*
- *Cardinality: number of tuples in a relationship.*
- *Logical keys: keys to represent the associations between two tables.*

Entity-relationship model

The E/R model provides a modeling tool to represent entities, properties, and relationships, called an entity-relationship diagram. Through this diagram, the abstract conceptual scheme can be graphically displayed and maintain conceptual independence with respect to the implementation itself (Moreno, 2000). It is used to locate specific data, its objective is the management and relationship of the data (Gordillo, Licona y Acosta, 2013).

Elements of an E/R model

The elements of the E/R model are as follows (Silberschatz *et al*., 2011):

- Entity: thing or object in the real world that is distinguishable from all other objects.
- Attributes: describe properties that each member of a set of entities possesses.
- Domain: set of values that an attribute can take.
- Relationship: association between different entities.

The increase in the number of entities, correlations and attributes results in an increase in complexity and cost. (Çağıltay, Topallı, Aykaç y Tokdemir, 2013).

Standardization

Database normalization (Codd, 1970) is the process by which an existing schema is modified to bring its component tables toward conforming to certain properties through a series of progressive normal forms. It is a subject that is not easy to assimilate by designers with little experience. Fortunately, there are technological developments aimed at supporting the standardization teaching-learning practice (Mendjoge, Joshi and Narvekar, 2016; Mitrovic, 2002). The normal forms that are generally considered are: first normal form (1FN), second normal form (2FN), third normal form (3FN), Boyce-Codd normal form (BCFN), fourth normal form (4FN), and fifth normal form. normal (5NF).

On constructivism

Due to the fact that the didactic strategy that is proposed is of a constructivist nature, in this regard it is commented that constructivism emphasizes socialization and the learning context, that is, that said learning is not acquired through the teaching of the topics by teachers, but rather it is acquired through the significant construction of knowledge under a certain context. During the process, the student must make use of the necessary learning materials, in such a way that the core of the constructivist theory is to take the student as the central object, emphasizing in himself the initiative of exploration, search for knowledge and construction of learning. significant (Zhuoyi *et al*., 2012).

Methods and materials

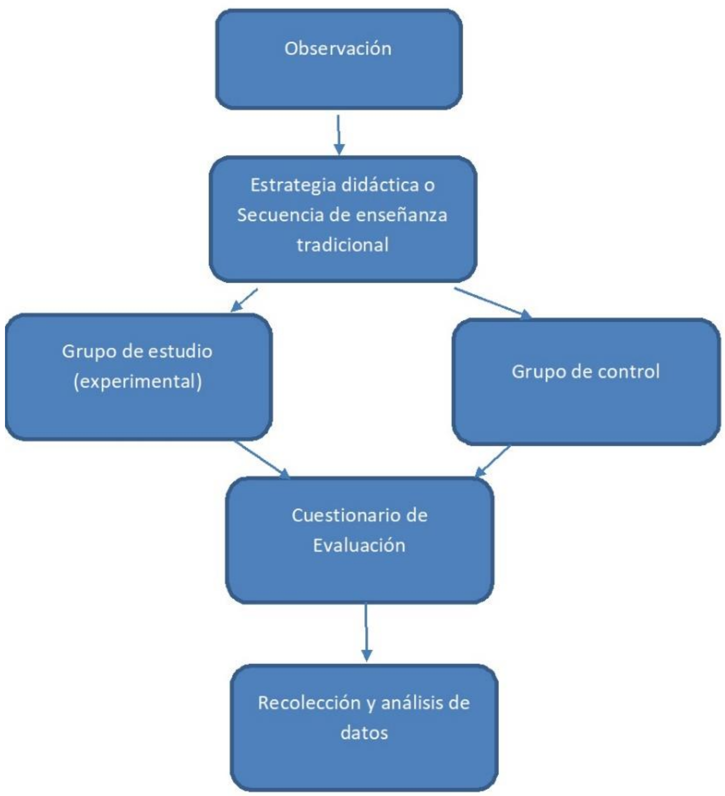
The research methodology used is qualitative with a descriptive scope, according to what was indicated by Hernández, Fernández and Baptista (2008).

We worked with two groups of 35 and 36 students, respectively. One of them was considered as a study group (experimental) with which the topic of data model was worked on with the proposed didactic strategy. The second group was the control group, where the same subject was developed, but using the traditional teaching sequence, mentioned in the introduction to this document, and which is summarized in the following steps: 1) use of the textbook by teacher to give the theory and present examples on the topics of relational model, E/R model, relationship between them and normalization process, 2) development of the E/R model using a given example, 3) transformation of the E/R model to the relational model and 4) application of the normalization process, if necessary. The groups were made up of fourth-semester students of the CECyT 9 Programming technical career of the IPN. The age of the students ranged from 16 to 17 years. The topic addressed with both groups was data modeling, which is located in thematic unit 1 corresponding to the Database learning unit. To review the previous knowledge of the students of both groups (control and study), the first methodological instrument was used, which was the observation prior to the work on the subject of the data model, and, to evaluate the work carried out, in both groups an evaluation questionnaire was applied.

The didactic strategy proposed in this article is of a constructivist nature, centered on the student, which led to modify the traditional teaching sequence in such a way that students who take the subject for the first time, therefore, do not experience in database modeling, are capable of generating relational models and E/R through experimentation and treatment of the information provided. The sequence of steps that is proposed to follow is the following: 1) take a real world situation that is familiar to the student, 2) identify, through the example, the characteristics of the relational model and, once the student has assimilated them, , explain the formal concept, 3) proceed as in the previous step to present the issue of normalization in its different forms and 4) transform the relational model obtained to the corresponding E/R model. As can be seen, with this way of proceeding, student learning is favored, since the topics are addressed in a dynamic way, with the constructivist approach. By using this didactic strategy, the topics are presented from a perspective that starts from the most particular to the most general, unlike the traditional way, which proceeds in reverse and, in some cases, exposes this topic superficially, because When starting from the E/R model to the relational model, the normalization process may not be necessary, which is why, in this more dynamic proposal, the subject of normalization is presented in a broader and more intuitive way. On the other hand, the teacher will be given a tool to intuitively and experimentally instruct students in the construction of said models.

The diagram in Figure 1 shows the steps followed in the research methodology.

Figure 1. Process used in the research methodology



Source: self made

Observation

Observation is taken as the basis for data collection in empirical research and can have different fundamental meanings (Cohen, Manion, Morrison, 2007). In the case of the study reported in this article, observation was used as a methodological instrument that allowed obtaining a general knowledge of the groups with which the teaching experience was generated.

Observation in the classroom is a means of exploring the teaching and learning processes on the topic of data modeling. The purpose of this observation was to recognize the patterns of prior teaching with which students are familiar, including the type of interaction they are accustomed to with their teachers and the use of technology. At the same time, the observations made showed the general conditions of the group and helped in the comparison that was made between the way of working that the students were used to doing with their teachers and the development they had with the person in charge of this research within the teaching experience presented in this article.

Before carrying out the scheduled observation, a selection of criteria was made about how to anticipate its records, what phenomena to privilege in it, how to validate it in different ways and the elements of analysis to be deepened later.

Everything raised so far responds to the following questions and points of interest:

- What are you trying to observe?
- Nature of the teaching that the teacher promotes.
- At the level of the teacher's discourse, the definitions that he provides and, at the level of what he says, how he says it and what meaning he gives it.
- Strategies that students use when solving problems.
- What students say and how they say it.
- What students write and how they write it.
- What other elements are present? (for example, what refers to the collective discourse, the type of group exchange, etc.).

As a result of the observation, it is found that the students of both the control group and the experimental group take the Database subject for the first time and the way in which they describe the classes they have had with their teacher is traditional (expository).), that is, the teacher gives the theory extracted from a textbook and gives examples, that is, the teacher is in charge of explaining supported by examples, he asks some questions to make the students participate, there is no group exchange, the students They copy what is written on the board into their notebooks.

Classroom work proposal (didactic strategy with the study or experimental group and teaching sequence with the control group)

The work carried out with the control and study or experimental groups is shown below.

Work in the classroom with the control group

With the control group the traditional teaching sequence was used. The steps used and the activities carried out are shown below:

- Study of theoretical foundations of databases.
- Study of database models and types of models.
- Definition, characteristics, elements and notation of E/R modeling.
- Analysis and mapping of a problem posed by transforming the conceptual model into a set of candidate relationships.
- Definition, examples and characteristics of normal forms.
- Application of normal rules so that the candidate relationships are refined to eliminate data redundancy.

Work in the classroom with the study or experimental group

The didactic strategy was worked with the experimental group, which is integrated by six phases that start from the analysis of a real case until the construction of the relational and E/R models. This strategy is based on a constructivist model by virtue of the fact that the acquisition of significant knowledge is proposed through experimentation by the student. Next, the six phases of this didactic strategy are presented, which were carried out considering an example of products available in a grocery store but it is applicable to any situation.

Phase 1. Analysis of a real world case

Students are presented with images of the products that can be purchased in a grocery store and, through brainstorming, the student is asked to determine the common characteristics of all products (here, an aspect of constructivism referred to as the student participate experimenting and working with elements close to their reality).

Phase 2. Treatment of information in tabular form using a spreadsheet

With the information obtained from the observation and analysis of the products, the student generates a tabular representation, as shown in Table 1, where each attribute is placed as a row in the table. At this point, it is important to observe and guide the student in the choice of attributes, since they may have chosen those that are irrelevant to the subject or, in contrast, not have taken some into account (the experimentation by the student continues as an aspect of constructivism). Since the most important thing to achieve is abstraction, at this stage the formats of row names or data types are not relevant.

Table 1. data tabulation

Nombre
Precio
Marca
Descripción
Categoría
Vendedor

Source: self made

Once the rows have been assigned, the table must be filled with information (records or columns), as shown in Table 2, in this way it is possible to identify if the appropriate rows were determined to describe the characteristics of all the products or if it is It is necessary to add more to describe information not previously taken into account.

Table 2. tabular report of records

Nombre	Leche	Cereal azucarado	Helado
Precio	11.00	15.00	30.00, 15.00
Marca	Pura, Milky	Cerealitos, CA	Heladines, Freezes
Descripción	Caducidad: cinco días, sabor chocolate, fresa, vainilla	Hojuelas azucaradas, maíz inflado chocolate, sabor frutal	A base de leche. Sabor: chocolate, napolitano, fresa
Categoría	Lácteo	Cereal	Congelado
Vendedor	Ana González	Ana González	Luis Gómez

Source: self made

Through observation and analysis of Table 2, the following can be identified:

- Duplicate values (Brand, Buyer).
- Existence of columns with heterogeneous information (Description).
- Inconsistent values (In the Description column: “Size of values”: “Small” and “Small” refer to the same concept, but are described in different ways).
- Multi-valued fields (Brand).

Once the characteristics that generate redundancy and inconsistency of the data have been observed, treatments are applied to the information (there is still a constructivist type of work that encourages the student to observe and reflect on what they are doing).

Phase 3. Application of normalization algorithms through the information processing process

The student is asked to identify non-atomic columns, that is, those that contain heterogeneous information (Description) and separate the information by creating new rows as illustrated in Table 3.

Table 3. Application of the atomicity property

Nombre	Leche	Cereal	Helado
Precio	11.00	15.00	30.00, 15.00
Marca	Pura, Milky	Cerealitos, CA	Heladines, Freezes
Descripción	Caducidad: cinco días	Hojuelas azucaradas, maíz inflado	A base de leche
Sabor	Chocolate, fresa, vainilla	Azúcar, chocolate, frutas	Chocolate, napolitano, fresa
Categoría	Lácteo	Cereal	Congelado
Vendedor	Ana González	Ana González	Luis Gómez

Source: self made

The student is asked to add a unique identifier called hereinafter identifier or primary key that uniquely represents each record in the table, as shown in Table 4.

Table 4. Unique identifier assignment for each record

Identificador Producto	23567	29643	93458
Nombre	Leche	Cereal	Helado
Precio	11.00	15.00	30.00, 15.00
Marca	Pura, Milky	Cerealitos, CA	Heladines, Freezes
Descripción	Caducidad: cinco días	Hojuelas azucaradas, maíz inflado	A base de leche
Sabor	Chocolate, fresa, vainilla	Azúcar, chocolate, frutas	Chocolate, napolitano, fresa
Categoría	Lácteo	Cereal	Congelado
Vendedor	Ana González	Ana González	Luis Gómez

Source: self made

In tables 5 and 6, those rows (Seller) that do not directly depend on the identifier are separated into independent tables, with their own identifier. In order for the student to be able to distinguish them, they are required to analyze whether these rows contain a value when registering the row for the first time. In the present example, the Salesperson row is separated because it does not depend on the product identifier and also remains without value until the sale process is performed.

Table 5. Separation of rows independent of the primary key

Identificador Producto	23567	29643	93458
Nombre	Leche	Cereal	Helado
Precio	11.00	15.00	30.00, 15.00
Marca	Pura, Milky	Cerealitos, CA	Heladines, Freezes
Descripción	Caducidad: cinco días	Hojuelas azucaradas, maíz inflado	A base de leche
Sabor	Chocolate, fresa, vainilla	Azúcar, chocolate, frutas	Chocolate, napolitano, fresa
Categoría	Lácteo	Cereal	Congelado

Source: self made

Table 6. row separation

Identificador Vendedor	10	20
Nombre Vendedor	Ana González	Luis Gómez

Source: self made

In order to keep the data related, an intermediate table is created which allows the data to be related through their identifiers and data is grouped by affinity (brand, flavor, presentation) and create new tables, again preserving the relationships through the main identifiers of each of these, as shown in Table 7.

Table 7. Generation of tables by affinity

Identificador Producto	23567	29643	93458
Nombre	Leche	Cereal	Helado
Precio	11.00	15.00	30.00, 15.00
Identificador Marca	M1, M2	M3, M4	M5, M6
Descripción	Caducidad: cinco días	Hojuelas azucaradas, maíz inflado	A base de leche
Identificador Sabor	S1, S2, S3	S4, S1, S5	S1, S6, S2
Identificador Categoría	C1	C2	C3

Source: self made

As can be seen, tables, repositories or catalogs are created that can be filled by values written only once, ensuring data consistency.

At this level, there may be rows that contain many values (BrandIdentifier, FlavorIdentifier), which are called multi-valued rows, which must be extracted by creating new tables that are capable of creating relationships through identifiers to subsequently eliminate the ones. rows.

From a business analysis, it can be identified that the Price row is a multivalued row, it is possible to extract it given its codependency with the Brand table, so the Price row can be moved to the table that relates the brand to the product , such a process is observed in tables 8, 9 and 10.

Table 8. Removing multivalued fields and codependent columns

Identificador Producto	23567	29643	93458
Nombre	Leche	Cereal	Helado
Descripción	Caducidad: cinco días	Hojuelas azucaradas, maíz inflado	A base de leche
Identificador Categoría	C1	C2	C3

Source: self made

Table 9. Removing multivalued fields and codependent columns

Identificador Marca	M1	M2	M3	M4	M5	M6
Identificador Producto	23567	23567	29643	29643	93458	93458
Precio	11.00	11.00	15.00	15.00	30.00	15.00

Source: self made

Table 10. Removing multivalued fields and codependent columns

Identificador Marca	M1	M2	M3	M4	M5	M6
Marca	Pura	Milky	Cerealitos	CA	Heladines	Freezes

Source: self made

Going back to the table generated in step 3, there is still a multivalued row (Identificador Producto), to which the same treatment indicated in step 6 can be applied.

Phase 4. Generation of the relational model

Given the nature of the results in tables, we proceed to the realization of the relational model (figure 2) through the following sequence: 1) first, a name is assigned to each and every one of the generated tables, 2) the column values, that is, only the table headers are kept, 3) later, the tables are located without an established order so that, finally, 4) in cases where there is a relationship between identifiers, said relationship is represented by lines (With these steps carried out, the total participation of the student in the construction of knowledge is observed, which in this case is the creation of a relational model, from everything done with the separation of the rows of the tables).

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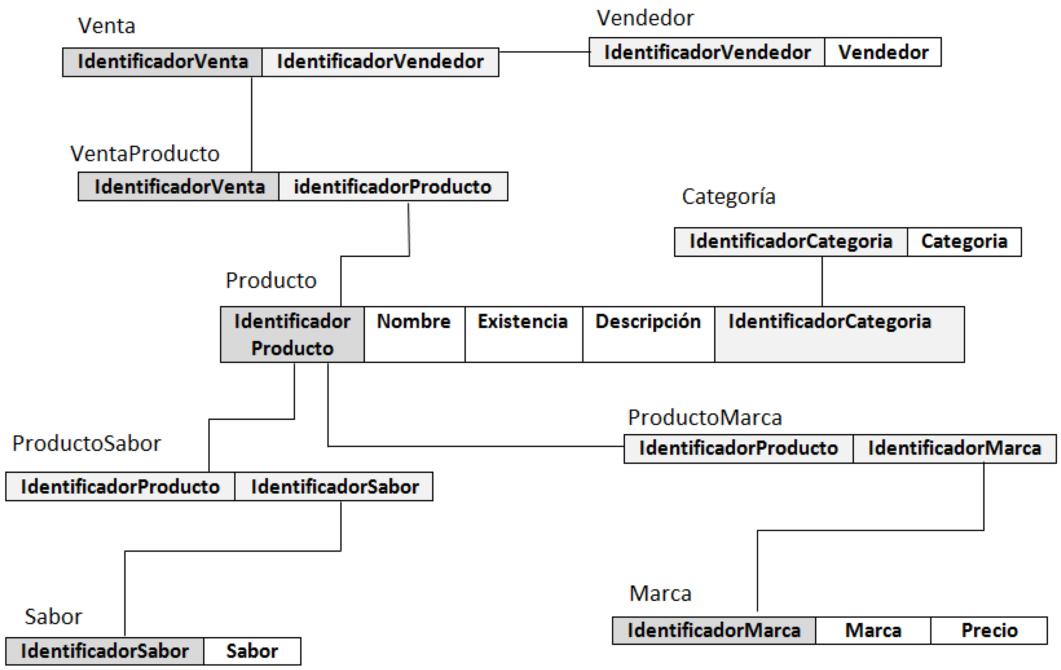
Figure 2. Relational model obtained from the exposed case



Source: self made

Phase 5. E/R model generation

Once the relational model has been obtained, the standard nomenclature can be used for representation by an entity-relationship diagram, where each table is represented by an entity (rectangle), columns are represented as attributes (oval) and the union between tables as a relationship (diamond), which indicates the identifier by means of which the relationship is made. An entity-relationship diagram should include the rows of each table represented by outgoing ovals of the entity, however, to make it easier to visualize relationships, they have been suppressed in Figure 3.

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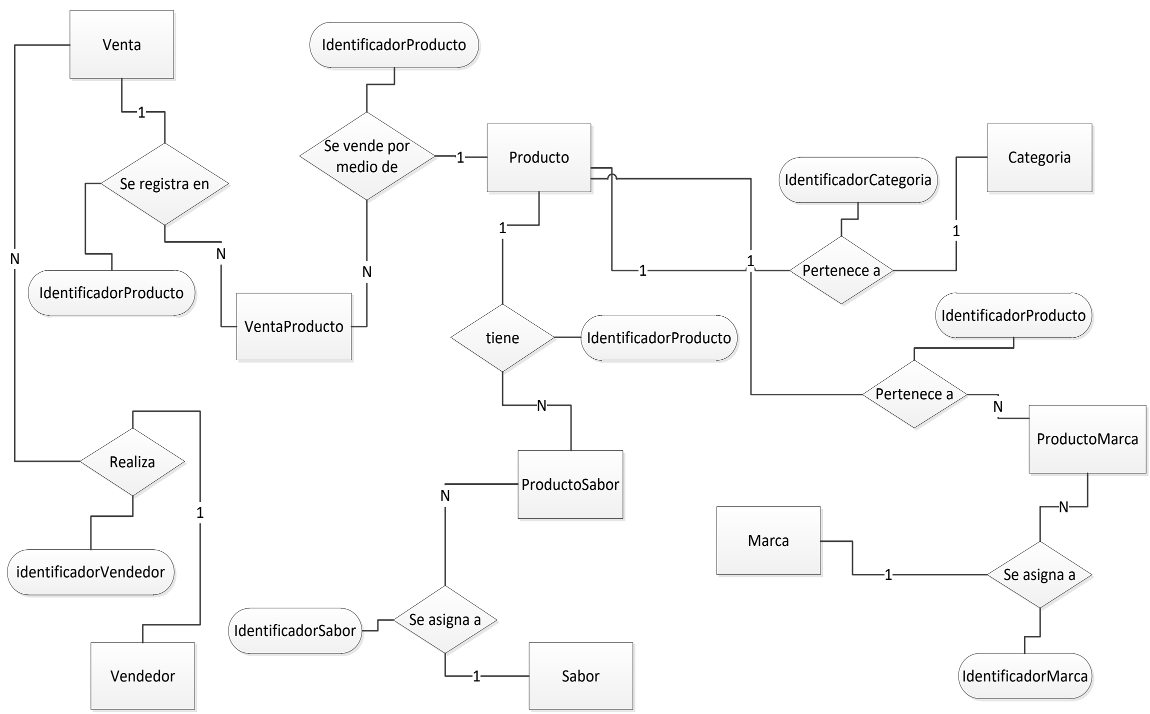
Figure 3. E/R model obtained from the exposed case



Source: self made

As can be seen in the diagram obtained in figure 3, the application of some normal form is no longer necessary, since all the relationships are established in the form 1:1, 1:N, N:1, and there are no multivalued attributes either. or derivatives, for which a model without redundancy and without inconsistencies has been generated. Also, it is possible to appreciate the correspondence between the models shown in figure 2 and figure 3, where 1:1 relationships are transformed only by passing the primary key of one table as a foreign key attribute of the other table, without the need to generate new tables. The same is true for 1:N relationships.

Phase 6. Evaluation questionnaire

After having worked with the experimental group on the didactic strategy and with the control group on the traditional teaching sequence, the same evaluation questionnaire was applied to both groups, which lasted 2 hours and which consisted of assigning a value according to 10 indicators (criteria that were taken into account to evaluate the student's knowledge on the subject, namely: the level of abstraction to generate a correct data model, the adequate application of the normalization process and the understanding of the symbology or nomenclature of each model) on a scale of 0 to 10 to determine the ease in building a data model. The evaluation questionnaire is presented in Table 11.

Table 11. Evaluation Questionnaire Information

Instrucciones: analiza el siguiente escenario y realiza en una hoja de papel el modelo E/R normalizado (al menos BCFN) utilizando nomenclatura estándar. Considere un sistema donde se administra información de vuelos de la aerolínea Volarás, la cual es una línea comercial dedicada a transportar pasajeros. De la misma, se sabe la siguiente información: • A cada pasajero se le asigna un identificador único de cuatro dígitos para abordar. • Interesa conocer el nombre completo (nombre, apellido paterno y materno), sexo, fecha de nacimiento y CURP de todos los pasajeros. • Para un vuelo se asigna fecha y hora de salida, fecha y hora de llegada, ciudad de origen, ciudad de destino y precio. • Para un vuelo, se asigna un identificador de cinco dígitos del número de vuelo, ciudad de origen y ciudad de destino. • Interesa determinar qué avión se designará para cada vuelo, por lo que se asigna un número que sirve como identificador de dicho avión y su tipo asignado por fabricante (Boeing 737, 747, 757 y 767 y Airbus A320, A330 y A340). • Un pasajero puede tomar varios vuelos. • Un vuelo puede reservarse para muchos pasajeros. • Los vuelos no pueden tener más de dos escalas y no hay cambio de tipo de avión para un mismo número de vuelo. *a)* Elabore modelo E/R para la solución del caso expuesto. Se evaluará: *i)* Uso de nomenclatura estándar (entidades y relaciones). *ii)* Representación de *todos* los atributos. *iii)* Cardinalidad. *iv*) Representación de llaves primarias y foráneas.

b) Elabore la reducción a tablas del modelo. Se evaluará:

i) Reducción fiel del modelo E/R

ii) Representación de llaves primarias(*), foráneas(**) y candidatas(***)

c) Elabore un diccionario de datos. Se evaluará:

i) Integración de todos los campos incluidos en el modelo E/R.

ii) Descripción completa de todos los campos incluidos en el modelo E/R.

Source: self made

The indicators that were considered for the evaluation, with which the comparison of the results obtained with the experimental group and the control group is made, are shown in table 12.

Table 12. Indicators of construction of a data model

Núm.	Indicador	Descripción
1	Uso de nomenclatura estándar	- Representación de entidad mediante un rectángulo con el nombre de esta dentro. - Representación de atributo por medio de un óvalo con su nombre inscrito unido a la entidad perteneciente por medio de una línea de conexión. - Representación de llave principal subrayada. - Representación de relación a través de un rombo unido por líneas conectoras entre entidades, dominio y codominio. - Representación de cardinalidad indicada en cada relación por medio de: 1:1, 1: N, M: 1, M: N, o bien simbología gráfica: l, > l y l <.
2	Identificación de entidades	- Abstracción a través de conceptos clave del escenario, que son representados como entidades. - Entidades categorizadas por: fuertes o dominio (rectángulo inscrito) y débiles o codominio.
3	Identificación de atributos	- Abstracción de las características pertenecientes a cada entidad.

		- Atributos categorizados por: simple, compuesto o derivado. - Elección de atributo como llave principal.
4	Relación entre entidades	- Elección adecuada de llave foránea. - Indicada según el sentido de la relación.
5	Aplicación 1FN	- Los atributos en todas las entidades cumplen con la característica de atomicidad. - La entidad contiene una clave principal.
6	Aplicación 2FN	- Dependencia funcional completa: cada atributo de la entidad depende de la clave principal.
7	Aplicación 3FN	- No existe ninguna dependencia funcional transitiva entre los atributos que no son clave, es decir, cada atributo que no está incluido en la clave principal no depende transitivamente de esta. - Ningún atributo debe depender de una entidad que no tenga clave principal.
8	Aplicación BCFN	- La clave primaria está formada por solo un atributo. - Solo existen dependencias funcionales elementales que dependen de la clave principal o cualquier clave alternativa. - Las únicas dependencias funcionales elementales son aquellas en las que la clave principal determina un atributo. - Agrupamiento de datos por afinidad formando entidades relacionadas entre sí mediante atributos comunes.
9	Aplicación 4FN	- En una entidad no existen atributos multivaluados y se generaron todas las relaciones externas con otras entidades. - Eliminar dependencias multivalor, es decir, existencia de relaciones independientes M: N
10	Aplicación 5FN	- Toda dependencia de la entidad viene implicada por claves candidatas. - No existen relaciones de dependencias no triviales que no siguen los criterios de las llaves principales. - Cada relación de dependencia se encuentra definida por llaves candidatas

Source: self made

Once the questionnaire was completed, the data was analyzed by group, which corresponds to the results part of this document.

Results

Evaluation of the experimental group (group 1)

Table 13 shows the percentages of indicators achieved by group 1.

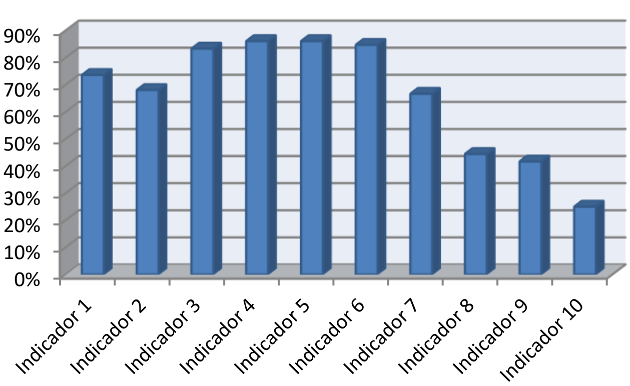
Table 13. Percentage results of indicators obtained by group 1 in the construction of a data model.

Indicador	1	2	3	4	5	6	7	8	9	10
Porcentaje obtenido	74 %	68 %	83 %	86 %	86 %	85 %	67 %	44 %	42 %	25 %

Source: self made

The group obtained an average of 6.72 in a weighting of 1 to 10, taking 10 as the maximum achievement of indicators. The histogram of Figure 4 graphically shows the percentages of indicators achieved by the students belonging to group 1.

Figure 4. Percentage graph of the number of students in group 1 who obtained each indicator



Source: self made

Evaluation of the control group (group 2)

Table 14 shows the percentages of indicators achieved by group 2.

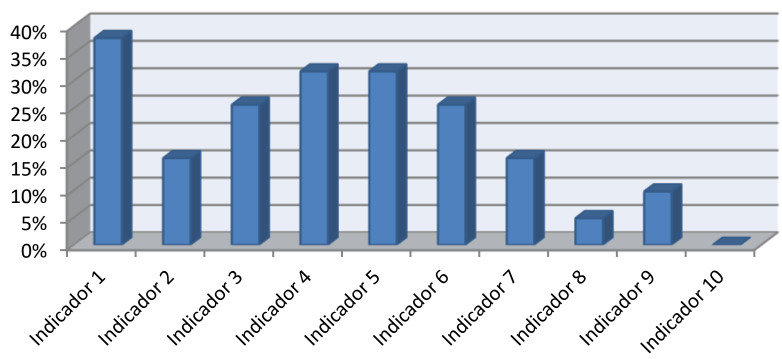
Table 14. Percentage results of indicators obtained by group 2 in the construction of a data model

Indicador	1	2	3	4	5	6	7	8	9	10
Porcentaje obtenido	36 %	17 %	25 %	33 %	33 %	25 %	14 %	3 %	6 %	0 %

Source: self made

The group obtained an average of 2.11 in a weighting of 1 to 10, taking 10 as the maximum achievement of indicators. The histogram in figure 5 graphically shows the percentages of indicators achieved by the students belonging to group 2.

Figure 5. Percentage graph of the number of students in group 2 who obtained each indicator



Source: self made

Finally, Figure 6 illustrates the average of indicators achieved by group.

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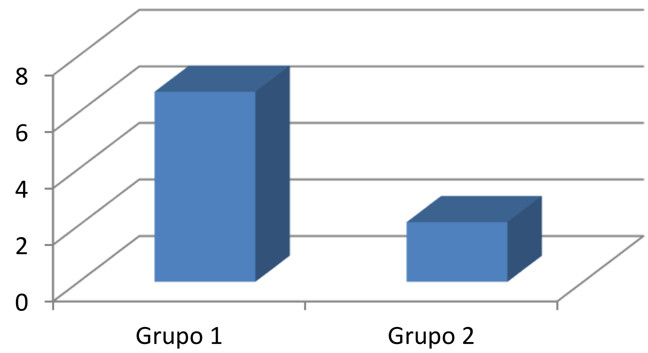
Figure 6. Average indicators achieved by group



Source: self made

From examining the characteristics of the results, it is evident that a large majority of the students managed to achieve mainly two indicators in their designs: 1NF and 2NF. However, in the experimental group, where the didactic strategy was applied, the indicators related to the identification of entities, attributes and relationships predominated and in many cases they managed to implement the 5NF; while in the group where priority was given to theory, better results were achieved in the application of standard notation without reaching the 5NF. From the analysis it can also be observed that the students of the experimental group were able to manage to design models with a greater number of identifiers reached.

Discussion

This study proves that there is a great need to update teaching-learning techniques in this field, which coincides with what was mentioned by Rubio (2017). In general, teachers focus on theoretical knowledge leaving aside the relationship that exists with practice, as it appears in most textbooks (Silberschatz et al., 2002, 2011). Traditional methods of teaching databases for further assignment of practical skills do not generate the best results, however, it cannot be denied that students can still gain some practical operating skills.

Due to the high complexity of the databases, the conceptual models need to be improved so that it is possible to implement high quality databases. A good design is necessary for a good implementation and allows the identification of errors and inconsistencies in the system.

This research has shown a technique whose main purpose is to provide an experimental practical orientation that helps students of database courses to develop and build conceptual models of data with the maximum semantic content, which coincides with what was indicated by Zhuoyi et al. . (2012). In the same way, teachers will be able to encourage students to agree on theory to make sense of what has been practiced, a situation that, consequently, will help them to obtain knowledge about the course contents, models and tools, while gaining skills in how to operate. practically.

Conclusions

The implementation of databases in software systems has made this one of the central topics in the fields of IT and systems development. Such importance lies in the growing demand for technological solutions by organizations, which in turn causes a great demand for specialists in the subject. Therefore, in educational centers oriented to the field, actions must be taken so that educational strategies for teaching database courses promote the practical application of knowledge, that is, theory and practice must be combined. .

If a study program focuses on teaching students the theoretical foundations first and then places more emphasis on a database management system for data manipulation, the process of analysis and problem solving is missing. On the other hand, students will only be able to memorize knowledge if only a theoretical exam is used as an evaluation method, minimizing their ability to apply theory in practice. Education should focus on developing significant learning in students, and that is the intention of the technique suggested in this study.

Future lines of research

Aspects that can be worked on in the future are: developing a computer application based on the proposed didactic strategy that allows it to be used for different examples in the Database learning unit.

References

Arora, S. (2015). A comparative study on temporal database models: A survey. Paper presented at the 2015 International Symposium on Advanced Computing and Communication. Silchar, September 14-15, 2015.

Beynon-Davies, P. (2018). *Sistemas de bases de datos*. Madrid, España: Reverté.

Çağıltay, N. E., Topallı, D., Aykaç, Y. E. y Tokdemir, G. (2013). Abstract conceptual database model approach. Paper presented at the 2013 Science and Information Conference. London, October 7-9, 2013.

Castelltort, A. and Laurent, A. (2013). Representing history in graph-oriented NoSQL databases: A versioning system. Paper presented at the Eighth International Conference on Digital Information Management. Islamabad, September 10-12, 2013.

Cattell, R. G. G., Barry, D., Bartels, D., Berler, M., Eastman, J., Gamerman, S., Jordan, D., Springer, A., Strickland, H. and Wade, D. (1997). *The Object Database Standard: ODMG 2.0*. New York, United States: Macmillan Publishers.

Chen, P. (1976). The entity-relationship model—toward a unified view of data. *ACM Transactions on Database Systems*, *1*(1), 9-36.

Codd, E. F. (1970). A Relational Model of Data for Large Shared Data Banks. *Communications of the ACM*, *13*(6), 377-387.

Cohen, L., Manion, L. and Morrison, K. (2007). *Research Methods in Education* (6th ed.). New York, United States: Routledge.

Gordillo, A., Licona, D. y Acosta, E. (2013). *Desarrollo y aprendizaje organizacional*. México: Trillas.

Hernández, R., Fernández, C. y Baptista, C. (2008). *Metodología de la investigación*. México: McGraw-Hill.

Khoshafian, S. (1993). *Object-Oriented Databases*. New York, United States: John Wiley & Sons.

Mendjoge, N., Joshi, A. R. and Narvekar, M. (2016). Intelligent tutoring system for Database Normalization. Paper presented at the 2016 International Conference on Computing Communication Control and Automation. Pune, August 12-13, 2016.

Miguel, A. D. y Piattini, M. G. (1999). *Fundamentos y modelos de bases de datos* (2.ª ed.). México: Alfa Omega.

Mitrovic, A. (2002). NORMIT: a Web-enabled tutor for database normalization. Paper presented at the International Conference on Computers in Education. Auckland, December 3-6, 2002.

Moreno, A. (2000). Diseño e implementación de un lexicón computacional para lexicografía y traducción automática. *Estudios de Lingüística del Español*, *9*.

Pisco, Á., Regalado, J. J., Gutiérrez, J., Quimis, O., Marcillo, K. y Marcillo, J. (2017). *Fundamentos sobre la gestión de base de datos*. Aloy, España: 3Ciencias.

Rashid, T. A. and Al-Radhy, R. S. (2014). Transformations to issues in teaching, learning, and assessing methods in databases courses. Paper presented at the 2014 IEEE International Conference on Teaching, Assessment and Learning for Engineering.

Rubio, J. M. (2017). Bases de datos. Universidad Católica de Valparaíso. Recuperado de http://zeus.inf.ucv.cl/~jrubio/docs/ICI%20344/Capitulo%20IV%20Parte%201.pdf.

Silberschatz, A., Korth, H. F. y Sudarshan, S. (2002). *Fundamentos de bases de datos* (4.ª ed.). España, Madrid: McGraw-Hill.

Silberschatz, A., Korth, H. F. and Sudarshan, S. (2011). *Database System Concepts* (6th ed.). New York, United States: McGraw-Hill.

Zhuoyi, C., Na, L. and Hongjie, Z. (2012). Exploration of Teaching Model of the Database Course Based on Constructivism Learning Theory. Paper presented at the 2nd International Conference on Consumer Electronics, Communications and Networks. Yichang, April 21-23, 2012.

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