Education for Critical Citizens: Relational Database and IBGE Data in High School

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Abstract. This study investigated the application of the relational database as an active methodology in high school, together with the analysis of data from national bodies, such as IBGE from Brazil. The main objective was to encourage the development of critical citizenship among students while learning content. The methodology used predominantly involved a bibliographical review, using Paulo Freire's ideas and mathematics textbook examples as the main basis. Also, the MySQL Workbench tool was used for a practical illustration of how all this could work in the classroom, alongside IBGE research and applications. All of this was developed so that the student can learn the content and visualize how the knowledge obtained can be useful in the real world, not just within school. Although the results were theoretical, the article highlighted the potential for transformation in the educational field, highlighting the need for reformulations in curriculum planning. Reflections were also raised about the better-planned use of technology in education, as the opposite of this can further contribute to a school curriculum that does not encourage students' critical thinking. In summary, this innovative approach sought to enrich students' learning experience, promoting critical citizenship, and aiming for a more meaningful and relevant education through the use of technological tools.

Keywords. SQL, Problem Based-Learning, national data, classroom, critical thought.

1. Introduction

Firstly, it is known that the use of a database (a collection of data) in many fields, is a technology made to provide a convenient and efficient way to store and retrieve information. These fields encompass companies, universities, airlines, web services, etc. It happens because of the possibilities offered by this system, mentioned by Silberschatz [1]: specificity and consistency of the data, facility of access, respect for the uniqueness of each data point, and other reasons. Consequently, two types of databases emerged: relational and non-relational databases. For this article, the focus was on the relational model. This type consists of organizing data in tables, which is commonly used by a statistical body from Brazil: the Brazilian Institute of Geography and Statistics; in Portuguese, the acronym is “IBGE” an abbreviation of “Instituto Brasileiro de Geografia e Estatística”. For example, there is the 2010s demographic census methodology [2] that cites the application of SQL, a relational database language, in one of your data load management steps. The relationship between these two areas, computing and statistics, emphasizes the importance of this type of organ and its delegation in a society. The IBGE makes it clear when, on your national website [3], it describes its mission as "Portray Brazil with the necessary information to understand its reality and exercise citizenship". However, is that enough for the citizens to practice their citizenship?

The answer to the previous question is negative. Following this line of reasoning, an important institution that has the power to develop critical thought is the school. Paulo Freire, a Brazilian educator, devoted most of his life to pedagogy and understanding the role of education. For him, education can have a liberating character [4] because it makes the human being reinvent reality through self-reflection when the knowledge is received. Unfortunately, the application of this criticality in favor of true citizenship is not yet a reality. So, thinking about these themes, this article aimed to hypothesize and formulate an active methodology mixing database concepts and data found for a national body; in this particular case, the focus was on the Brazilian organization, IBGE, in favor of society, with education as a reference in this process. The methodology developed falls under the so-called “Problem-Based Learning” (PBL), as teaching is student-centered and based on problem-solving [5]. In addition, the use of active methodologies is a form of teaching that distances itself from the traditional [6], positively relating to Paulo Freire's ideas. They are also consistent with the guiding question of this study: "How can concepts from a relational database

and statistical data tools from a national body be used practically in classrooms to better understand the content and instigate a critical citizenship in students?". Finalizing the introduction, it is important to highlight that the objective here was not just to convince the use of these technologies in schools, even though there are already many digital tools being applied in this environment [7, 8]. On the contrary, it is more than that; it is a way of promoting awareness among the population about the power it has in the society in which it lives, a phenomenon that is still unknown and deserves further study.

2. Methodology

2.1. Use of the Google Scholar and MySQL Workbench:

A bibliographic research was conducted. This method was chosen because it was needed to read about what already existed to propose a way to integrate separated fields: relational database, statistical tools, education, and citizenship). The search happened in a search mechanism for scholarly literature, Google Scholar, using the strings: “Relational database AND statistic data”, “Relational Database AND Productivity”, “Citizenship AND Statistical Data”, “Database AND its importance”, “Technology AND Education”, “Active Methodology AND Technology” and “SQL AND schools”. Another tool used was MySQL Workbench [9] to demonstrate the use of relational database concepts in the classrooms. This tool was chosen because of its clarity in Relational Database and SQL concepts.

2.2. Use of a Brazilian didactic book:

Also, necessary to inform that one didactic book was selected and found on Google, searching for “What Brazilian didactic books are still used”. The selection of this book occurred because there was a curricular topic that related to relational databases and statistical data. For this, the chosen textbook was: “Matemática 1: Paiva“ (in English: Mathematics 1: Paiva) [10]. In the book for the 1st year of high school mathematics, the subject “Operations with Sets” was selected, between pages 24 and 32.

3. Results

3.1. General overview of results:

An active methodology was developed to integrate a relational database for “Operations with Sets” in high school. To build this methodology based on problem-solving, real IBGE applications and data were proposed to be used in the classrooms to raise awareness of citizenship in students. The correct use of the MySQL Workbench in this context was explained. One point to highlight is that there were limitations. This active methodology that uses relational databases in the school environment in favor of better learning and development of critical citizenship has not been tested, so the results were bibliographic in nature.

3.2. Bibliographic references found:

Regarding the use of some technology as an active methodology for learning, two articles were found and selected [14, 15]. To reflect on the active use of technology in education, two articles were selected [7, 8]. For database fundamentals, one book was selected [1]. To have Paulo Freire's ideas as foundations, two articles were selected [4, 13]. To have the definitions of active methodologies and their use in the area of education, two articles were selected [5, 6]. And, finally, to deal with issues related to statistical data and citizenship, pages from the official IBGE website were selected, [3, 11, 12]. All these references served as a basis to support the active methodology that was built as a result of this research.

4. Discussion

4.1. Part 1 of the Methodology’s application: relational database in the mathematics

In the content of Operations with Sets [10], it was possible to see the similarity with the relational database SQL language. This language is mainly used to query a database [1]. Here, it was not explained how a database fully works, but rather the basic concepts necessary for this technology to solve the problem exposed in the book differently than the traditional one. So, a topic explained in the book is the intersection between sets, represented in the image below, taken from Paiva's book:

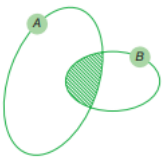

Fig. 1 - Intersection between sets

To explain this concept, the author used a practical example: “Cláudio is a customer of Banco Albano and Banco Belgrado. Considering sets A, of Banco Albano customers, and B, of Banco Belgrado customers, which of the two sets does Cláudio belong to? As can be seen from the information above, Cláudio belongs to both sets, as the connective “and”, in this case, indicates simultaneity, that is, Cláudio is a customer of both banks at the same time.”. Now, putting this practically and visibly in a database. First, we could have an Entity–Relationship Model (MER), which Silberchatz [1] points out as something that was developed to facilitate the understanding of a structure, a draft made before creating a database. In this case, the model used to illustrate Paiva's example can be very simple, using MySQL Workbench [9]:

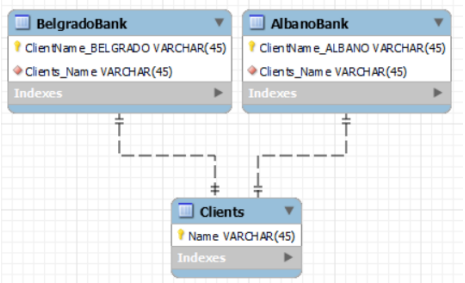

Fig. 2 - Entity-Relationship Model of the teaching example

In this entity-relationship model, "BelgradoBank" and "AlbanoBank" are entities. An entity represents an "object" in the real world [1]. Furthermore, in the field described below, "ClientName_BELGRADO" and "ClientName_ALBANO" would be the attributes of this entity. An attribute is a description of each member of an entity set [1]. So, this means that Banco Belgrade and Banco Albano have a table with the names of their customers. The dotted line, which connects both the Banco Belgrade entity and the Banco Albano entity to the "Customers" entity, is a one-to-one relationship. This relationship means that a customer can relate to a bank and a bank can relate to a customer. However, it is important to note that "one" does not mean "one unit", but rather that there is only one customer with that name. So, for example, a Customer table can have several names, but no name will be the same as the other. There is also the concept of the primary key, which serves to distinguish one entity from another [1] and allows the relationship between entities to occur. For people who are familiar with these concepts, it is already known that there is greater complexity about them. However, the objective is to superficially explain the basics of the relational database in this section and not go deeper beyond that because of the high school classroom context. This technology will be used as a simple support tool that allows for a different way of fixing content.

Finally, we look at the consultation part, which aims to verify whether Cláudio is a customer of Banco Belgrado and also of Banco Albano. To do this, it was necessary to use the INSERT command, which is used to insert data into a table. The syntax of this command can be as follows:

INSERT INTO entity (chave primária)
VALUES
('Valor 1'),
('Valor 2');

Then, in the "AlbanoBank" table, the following were inserted: 'Cláudio', 'Maria', 'Ana'. In the "BelgradoBank" table, the following were inserted: 'João', 'Claudio'. And in the "Customers" table, the following were inserted: 'Bruno', 'Natália', 'Claudio', 'Maria', 'Ana', 'João'. With this, two queries were formulated: one to check which customer is in the "Clients" and "AlbanoBank" table and the same for "Clients" and "BelgradoBank". These queries were made separately to facilitate understanding, reducing the size of the query. Therefore, the queries and their respective results looked like this:

SELECT NameClient_ALBANO **AS** 'Albano Bank', Name **FROM** Clients **JOIN** AlbanoBank **ON** Clients.Name = AlbanoBank.NameClient_ALBANO;

Albano Bank	Name
Ana	Ana
Cláudio	Claudio
Maria	Maria

Fig. 3 – Albano Bank results

SELECT NameClient_BELGRADO **AS** 'Belgrado Bank', Name **FROM** Clients **JOIN** BelgradoBank **ON** Clients.Name = BelgradoBank.NameClient_BELGRADO;

Belgrado Bank	Name
Cláudio	Claudio
João	João

Fig. 4 – Belgrado Bank results

For better understanding, the query for Albano Bank, which has the same structure as Belgrado Bank, can be translated as: select (SELECT) the names of customers and put 'Albano Bank' as the title in the result (AS command) and join (JOIN) the Customers table with the Banco Albano table, where (ON) the name of the Customers' table is the same as the name of the Banco Albano name table. This way, the example proposed by Paiva can be introduced through MySQL Workbench in a more direct and applicable way. Of course, this is a simple example, and little data was also used, as the objective was to demonstrate that Cláudio was connected to both banks at the same time. But, for this first part, it was enough for students to learn innovatively.

4.2. Part 2 of the Methodology's application: IBGE and citizenship

In the section before this, the focus of using the methodology was on the relational database and how it could be used to fix content. However, the methodology is not yet complete, because as noted in the introduction to this article, the main objective is about the real exercise of citizenship. So, for the methodology to make sense and achieve the objective, it was decided, firstly, that it is categorized into Problem-Based Learning, also called PBL (Problem-Based Learning). According to Paiva, Parente, Brandão, and Queriz, who dedicated themselves to analyzing the effectiveness of active methodologies in different educational contexts [6], it has been proven that active methodologies help in the construction of learning, which occurs as a result of the challenge of a problem situation. Furthermore, they can occur in many ways, not necessarily having a single form of application. For the high school classroom context, continuing with the subject of Set Operations taken from Paiva's book, Problem-Based Learning can be aimed at making learning more practical and motivating. This may be possible through the analysis of what may be possible to build with the knowledge acquired in this "Operations with Sets" content.

A possible construction that can be introduced to students and make them visualize the importance of what they are learning is the IBGE Geodetic Database [11], as well as the research and studies carried out by this body.

The Geodetic Database (BDG) is an application that was created so that the user can consult geodetic stations, to have more precise positions for mapping the national territory.

Fig. 5 - Demonstration of the use of BDG

In the image above, a table of results is shown, which appears after selecting a state in Brazil and, consequently, a municipality in that State. For this example, the state 'Paraná' and then the city 'Cornélio Procópio' were selected. With this, the geodetic stations were presented as reference. However, the point of citing this application here was not because of its concept itself, but rather of the way this results table appeared. It was possible to see the relationship between the results of the SQL queries presented previously when the objective was to check whether Cláudio was present in the Albano and Belgrade banks in the Geodetic Database, as the results also appeared in table format. Furthermore, as part of demonstrating to students the possible constructions with the knowledge obtained with mathematics and relational databases, statistical data from IBGE [12] could be introduced. The surveys are present on the agency's official website, making access easier for students.

The presentation of the Geodetic Database (BDG) and also the sources of all research already carried out by IBGE for students would reinforce the importance of the subject understood by them. According to Borges, Chachá, Quintana, Freitas, and Rodrigues, who deepened their research on Problem-Based Learning [5], concluded that this methodology, which is characterized by solving real problems, favors more meaningful and contextual learning for the student. It was possible to realize that, from using MySQL Workbench to build queries around an example proposed in Paiva's book to visualizing the importance of this content in real applications and research developed by IBGE, they could have the potential to make learning more practical and real, as it involved a real and very important body in Brazil. However, not only better learning can be developed, but also critical citizenship in the student.

In a research that was concerned with the implications of Paulo Freire about curriculum planning, Mahmoudi1, Khoshnood, and Babaei explained that one of the main foundations in curriculum planning from Paulo Freire's perspective was attention to the education of oppressed people [13]. Oppressed people, according to the educator, are all those who do not belong to the elite. Consequently, the education presented to them is not designed to open up questions and critical thinking. Therefore, Paulo Freire greatly reinforced the need to reformulate education, which can contribute to the development of greater criticality and student protagonism in their knowledge. Bearing this point in mind, it became possible to state that the methodology discussed during these two sections had this objective. This occurred because the use of a relational database aimed at explaining concepts in mathematics would place the student in a more autonomous role in the construction of their knowledge, who can understand the concept through a real application. And, the main factor would be the results of this interaction through more demonstrations, such as IBGE, which uses these mathematical concepts and the relational database in some of its stages to obtain data from its research and build applications. This way, students could better understand the content, in addition to being able to witness the importance of these concepts and become more interested in them. This research data could also be rounded up and used in the classroom through examples and exercises, encouraging students to learn about their country's situation in various areas. Thus, the development of critical citizenship, as highlighted by Paulo Freire and also in the IBGE mission [3], would be possible.

4.3. Comparison with other results: limitations and originalities

Four articles in total were chosen. The first and second focused on using active methodologies to teach what they intended. The third and fourth dealt with reflection on the integration between technology and education, which was very useful in formulating the main motivation for this research that was developed.

The first study that was selected went deeper into analyzing the integrated use of three active methodologies: flipped learning, problem-based learning, and gamification made by high school mathematics teachers [14]. The second study focused on a new Web-based learning environment for teaching databases and SQL in high school [15]. These two articles presented more consistent results, as they tested what they were defending in classrooms. Both articles also focused on presenting mathematics [14] and SQL [15] content in a more active way, that is, the student conducts their learning with the help of the teacher, which makes learning more beneficial and motivating. So, both studies presented positive results in their tests, which proved the effectiveness of active methodologies. With this, it became clear that the two main differences between this article and the first two that served as a reference were: the methodology and the objective. The methodology

used here was of a pure bibliographic nature, which did not make it entirely possible to prove the effectiveness of this methodology. However, at the same time, this research has similarities with the one that was developed. So, it would not make sense to discard what was produced here, as it is something that has the potential to improve the educational field through the computational field. Regarding the objective, it became clear during the explanation of how the methodology would work that the only target was not only the students' understanding of the subject but also the development of critical citizenship. It was something that the first [14] and the second [15] articles were not intended.

The third [7] article aimed to encourage the use of digital technologies in education, such as Google Classroom, Google Docs, Google Scholar, etc. Meanwhile, the fourth [8] focused on discussing the advantages and disadvantages of using technologies in education. This reflection proved necessary to be discussed here because, as pointed out by Cloete [8], the role of technology in the school environment should not only be for students to learn how to use it. It is necessary to integrate with the cultural and economic context in which this technology will be introduced. Given this, the study by Mucundanyi and Woodley [7] is important, as it is necessary to seek to use technologies that optimize education. However, relating this to the PBL methodology that was developed here, it mustn't be applied just to teach SQL or just to see national data about society without an interpretation of why this is being shown to students. Therefore, the ideal would be an educational system that has a structure for this, not only computational but also committed to the development of students' critical thinking. This is a limitation that this study presented, also highlighted by Cloete [8]: "Not only physical access is needed but also epistemological access, requiring both students and lecturers to be computer-literate as well as conventionally literate and numerate." However, this does not mean that the active methodology developed here cannot be part of the high school curriculum, as it would be very beneficial for students, future professionals, and, above all, citizens in society.

5. Conclusion

Relational database concepts have similarities with mathematics subjects in high school and demonstrating this to students can make them understand the content better, as it is an active methodology (PBL), proven as one of the best ways of learning. Developing critical citizenship requires curricular planning that goes beyond traditional teaching and that promotes critical thinking, as already highlighted by Paulo Freire, making students more aware of the problems that exist in their country. All of this has proven to be possible through the effective use of technology for these objectives, which cannot occur superficially, but rather in a way that focuses on the student's protagonism.

The methodology used was dedicated to existing bibliographies on these subjects. As well as the use of a textbook and a technological tool, MySQL Workbench, to build a better active methodology that would meet the objectives of this research. They proved efficient, as the research results and theoretical basis were obtained, as well as the ease that MySQL Workbench presented for building a practical example presented in the textbook.

Therefore, the importance of this article was notable. It managed to demonstrate how the relational database and statistical data from IBGE could be used as an active methodology in a high school class. And, how they have the potential to form more critical citizens who have learned the content seen at school. For future studies, it is necessary that this can be tested because as seen, this was the main limitation of this research. Another important point that could be further explored would be how to raise awareness among students through IBGE data, as it could be through interdisciplinary classes, such as mathematics and sociology, for example. Furthermore, there is a need for greater defense of Paulo Freire's ideas and the implementation of active methodologies in conjunction with the use of technology in a teaching environment. This is because this was also a limitation found: the school's curriculum planning, which is still being done in a way that does not develop critical citizens.

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