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USAGE OF ACTIVE METHODOLOGIES WHEN TEACHING BIG DATA AND DATA ANALYTICS (BD/DA): AN ANALYSIS FROM THE PERSPECTIVE OF ACCOUNTING STUDENTS

USO DE METODOLOGIAS ATIVAS NO ENSINO DE BIG DATA E DATA ANALYTICS (BD/DA): UMA ANÁLISE SOB A ÓTICA DOS DISCENTES DE CIÊNCIAS CONTÁBEIS

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ABSTRACT

This study aimed at examining the use of active methodologies to teach Big Data and Data Analytics (BD/DA) from the perspective of accounting students. We designed a specific BD/DA course for which students could register for free. It was offered in addition to the formal curriculum, and we used the Case Method (CM), Directed Study (DS), and Problem-Based Learning (PBL) along with Tableau to deliver content. Specifically, we adapted a case from a prior study. For data collection, we administered pre- and post-course surveys. We employed descriptive statistics, paired samples Wilcoxon tests, and Friedman's test as analysis techniques. Our findings indicate that, while students' knowledge of Excel remained the same before and after the course, there was a significant improvement in their knowledge regarding data visualization and analysis software packages. Students reported an increase in their ability to connect and visualize data, as well as performing calculations. CM assisted students in improving their individual study and data collection and analysis skills. DS particularly contributed to enhancing students' analytical skills and to better organize their knowledge of BD/DA. PBL provided students with concrete experience and was useful for integrating students' academic knowledge with their business world knowledge. Finally, we compared students' perceptions across active methodologies and found that there was no significant difference. It suggests that students perceived the three active methodologies in similar ways. Our findings have key implications for accounting education. First, we obtained evidence consistent with the benefits of active learning reported in previous literature. Second, we show that research can and must be integrated into education by using a teaching case. Finally, we also show that multiple techniques can be used satisfactorily to teach the same content or in the same course. Each teaching method has its strengths and weaknesses, and combining them might produce better learning outcomes.

Keywords: Active Learning. Big Data. Data Analytics. Data Analysis. Accounting.

RESUMO

A pesquisa objetivou analisar o uso de metodologias ativas no ensino de Big Data e Data Analytics (BD/DA) sob a perspectiva dos estudantes de contabilidade. A análise foi realizada em um curso de BD/DA disponibilizado gratuitamente. O curso foi oferecido de forma complementar às disciplinas e utilizou-se do Método do Caso (MC), Estudo Dirigido (ED) e Problem-Based Learning (PBL) com o uso do Tableau. O caso utilizado na análise foi adaptado da literatura. Para a coleta de dados, foi aplicado um questionário pré e pós curso. Utilizou-se estatísticas descritivas, teste de Friedman e pareado de Wilcoxon como técnicas de análise. Os resultados indicam que enquanto os conhecimentos sobre Excel dos estudantes permaneceram os mesmos antes e após o curso, houve uma melhora significativa no conhecimento sobre visualização dos dados e softwares. Estudantes relataram um aumento na habilidade para conectar e visualizar dados, assim como elaborar cálculos. MC auxiliou os estudantes a otimizar seus estudos para coleta e análises de dados. O ED contribuiu para aprimorar as habilidades analíticas e para a organização dos conhecimentos sobre BD/DA. O PBL forneceu aos estudantes uma experiência concreta e foi útil para integrar o conhecimento discente ao mundo empresarial. Por fim, comparou-se as percepções sobre as metodologias ativas e verificou-se que não houve diferença significativa, sugerindo que os estudantes perceberam as três metodologias de forma similar. Os achados têm implicações importantes para a educação contábil, primeiro, obteve-se evidências consistentes sobre os benefícios da aprendizagem ativa, como relatado na literatura. Em segundo lugar, demonstrou-se que a pesquisa pode e deve ser integrada ao ensino com o uso do MC. Finalmente, pode-se verificar que múltiplas técnicas podem ser utilizadas de forma satisfatória para ensinar o mesmo conteúdo. Cada método de ensino tem forças e fraquezas e a combinação deles pode produzir melhor resultado de aprendizagem.

Palavras-chave: Aprendizagem Ativa. Big data. Data Analytics. Análise de Dados. Contabilidade.

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1 INTRODUCTION

Companies use data analysis to make better business decisions, as well as to verify or compare existing models or theories (Enget, Saucedo, & Wright, 2017). In a new informational reality, large volumes of data with multiple characteristics and with different purposes are generated every second. This extremely voluminous dataset that cannot be analyzed using traditional data management software packages and systems is called Big Data (Syed, Gillela, & Venugopal, 2013).

Earley (2015) emphasizes that Big Data is seen as a trend in the business area, and organizations that do not keep up with the evolution in data analytics will have problems compared to their competitors and negative consequences on their results. In this regard, data visualization offers a relevant opportunity to gain information by allowing the comprehension of complex information in visual ways. A well-designed and meaningful data visualization provides immediate, actionable, and aesthetically interesting insights and is a resource for telling an engaging and meaningful data story (Ryan, 2016).

Notably, the ability to deal with data is particularly relevant to accountants since, historically, their practice involves recording, processing, and analyzing data for decision-making. Based on available analytical tools, accountants record, filter, summarize, and consolidate data in order to provide financial information to its stakeholders, whether internal or external (Janvrin & Watson, 2017). At present, when technological advances have facilitated and pluralized the forms of capturing, making available, and analyzing data, accountants must continue to develop their skills in these areas.

Likewise, it is necessary that accounting students seek to deepen their knowledge about data analysis and that they are given the opportunity to understand this topic already in the undergraduate program, in which data analysis techniques can be taught to explore large volumes of data. Students need to be able to extract and categorize data in a way that allows them to identify, analyze, and learn about behavioral patterns (Igou & Coe, 2016). As a result, students need new perspectives in teaching and must be exposed to data analysis training so that they are able to face what is increasingly becoming an important area for the accounting profession (Coyne, Coyne, & Walker, 2016).

Despite that, accounting programs seem to have not kept up with data analysis advancements observed in the practical field of accounting. In Pathways Commission's (2012) view, one of the main factors that hinder curriculum and pedagogical changes is the

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difficulty in incorporating cutting-edge innovation tools. To weaken this challenge, active teaching methodologies emerge as a key alternative to stimulate teamwork, involve students in case studies, and discuss science-based solutions (Masetto, 2012). Understanding how different attitudes, motivations, and teaching approaches are suitable for new generations of students is essential to optimize their learning (Worley, 2011).

Diesel, Baldez, and Martins (2017, p. 271) highlight that, in contrast to the traditional method, in which students assume a passive stance, "the active method proposes the inverse movement, that is, students are understood as historical subjects and, therefore, assume an active role in learning, since their experiences, knowledge, and opinions are valued as a starting point for the construction of knowledge."[i].

To Vendramin (2018), if the future accounting professional needs to meet the current expectations of the labor market, they should not receive training that only addresses such requirements, but training that includes critical thinking, an entrepreneurial posture, and the ability to always learn, in that, even after graduation, the student continues to be able to seek updating and adaptation to the changes that occur in the workplace.

When considering the combination between the relevance of skills to deal with massive amounts of data and the need for active educational practices, one can reflect upon what contributions can active teaching methodologies provide to accounting students' learning when applying Big Data and Data Analytics knowledge. Based on this reflection, the objective of this study is **to examine the accounting students' perception on the usage of active teaching methodologies to teach Big Data and Data Analytics (BD/DA)**.

In the international domain, prior research has developed and used cases in accounting undergraduate courses regarding data analysis (Hoelscher & Mortimer, 2018; Igou & Coe, 2016; Janvrin, Raschke, & Dilla, 2014; Kokina, Pachamanova, & Corbett, 2017; Weirich, Tschakert, & Kozlowski, 2018). It means this is an opportunity to provide evidence that this type of teaching strategy also works in Brazil since there is little research on accounting and BD/DA thus far (Nogueira, Albertin, Nasu & Marques, 2020). At the same time, in practical terms, the present study expects to encourage the incorporation of active methodologies and BD/DA tools into accounting programs. More specifically, this investigation explores the usage of the Directed Study and Case Study strategies along with Tableau, a data visualization software package.

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2 BACKGROUND

2.1 ACTIVE METHODOLOGIES

Historically, the teaching and learning processes developed in education at all levels bring marks that refer to the colonialist model, in which actions are fragmented and disjointed. In Anastasiou's (2015) view, in this system, the teacher has the role of explaining the content while the students basically have the task of fixing them. For Debald (2020, p. 1), "Brazilian education has rarely experienced innovation processes since the models experienced in practice in the national territory were based on the experiences of economically developed European countries[ii]". The author adds that educational practices gave more emphasis to theoretical aspects than to practical ones, which demonstrates a lack of interest on the part of the State and educational institutions in promoting innovative educational processes (Debald, 2020).

However, despite the heritage of this educational model coming across generations, for Piletti (2003), the evolution in the field of research in education has broken these traditional paradigms. This takes place at the heart of modern society that has been impacted and transformed by industrialization and urbanization processes whose effects have profoundly modified areas and aspects of the modern individual's social life.

A key response to conventional education methods is the adoption of active teaching strategies. "Active methodologies emphasize the protagonist role of the student, his/her direct, participatory and reflective involvement in all stages of the process, experimenting, drawing, creating, with teacher guidance.[iii]" (Bacich & Moran, 2018, p 3). They represent ways to guide the learning process in the transmission of knowledge, which seek to develop the student's critical capacity and, also, the qualification of professionals from different areas.

"Students and professionals leave the passive role and mere receivers of information, which has been attributed to them for so many centuries in traditional education, to assume an active role and protagonists in their own learning.[iv]" (Filatro & Cavalcanti, 2018, p. 18). In the accounting education scenario, Nagib (2018) highlights the importance of studying active methodologies, although he recognizes that they do not necessarily imply the solution to all the challenges that arise in the face of changes that have occurred, such as the new profile of students.

It is noteworthy that active methodologies use problematization, in a strategic way, in the teaching-learning process as they aim to reach and motivate students, who, faced with the

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problem, "stop, examine, reflect, relate their history and begin to resignify their discoveries[v]" (Berbel, 2011, p. 29). Additionally, "there are many possibilities for Active Methodologies, with the potential to lead students to autonomous learning[vi]" (Berbel, 2011, p. 30). In this work, we used two active teaching strategies, namely: the Case Method (CM) and Directed Study (DS). In the next subsections, we discuss each of them.

2.1.1 Case Method (CM)

The choice of the CM for this work is based on the recognition that it is a strategy that enables the development of teamwork and decision-making abilities of students, in addition to having an interdisciplinary character (Soares, Souza, Azevedo , Araujo, & Lima, 2019). Case-based learning is aimed at bringing the student closer to market practice through learning based on real cases (Soares et al, 2019).

Ikeda, Veludo-de-Oliveira, and Campomar (2007) consider the CM to be a pedagogical tool that relies on the involvement of students as active individuals during the learning process. CM is intended to "lead students to reflect on situations presented in the case, which may involve decision-making on the studied episode.[vii]" (Ikeda, Veludo-de-Oliveira, & Campomar, 2005, p. 142).

When utilized as a pedagogical tool in management and business courses, the CM can: (i) improve creativity and innovate decision-making processes; (ii) facilitate the development of intelligent decisions through practice as it fixes the student's mind on specific situations; (iii) provide real situations in the daily lives of organizations; (iv) simulate situations that require strategic decision-making; and (v) demand positioning from the student, stimulating the ability to solve problems (Jakka & Mantha, 2012).

2.1.2 Directed Study (DS)

The choice of the DS for this work considers the power of this strategy for the development of new skills, as it "awakens in the students a creative, innovative, critical attitude so that they can become dynamic subjects, responsible for transforming and overcoming the obsolete models existing in our social reality.[viii]" (Miranda, 2017, p. 92).

Leal and Borges (2016) have shown that the use of DS, together with lecturing, resulted in the most significant and effective teaching strategy in the perception of accounting undergraduates. Berwig, Cunha, Teodoro, and Colauto (2013, p. 123) emphasize that the

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directed study allows the student to situate himself critically, "extrapolate the text to the reality experienced, understand and interpret the proposed problems, resolve difficulties in understanding and propose alternative solutions; exercises in the student the ability to write what was read and interpret it; dynamic, creative and critical reading practice[ix]."

We indicate that DS is one of several techniques that can be used in the teaching-learning process. According to Miranda (2017, p. 79), "this is an activity carried out by the students, with question scripts previously developed by the teachers.[x]." According to the author, DS is an active and not passive activity, as the student needs to use their own creativity to interpret and analyze the content, and it is necessary to consider, above all, in the preparation of the script, the possible needs of the students (Miranda, 2017).

2.1.3 Problem-Based Learning (PBL)

Problem-Based Learning (PBL) is a discussion-centered method focusing on problem-solving (Leal et al., 2019). Adopting a strategy that focuses on solving problems is helpful for this work as it represents an active teaching methodology that differs from lecturing-format and other traditional teaching techniques and emphasizes students' active participation when discussing and solving the problems presented to them.

In PBL, a problem from professional practice is presented to students who will actively seek solutions, which involves not only the analysis of its solution but the entire process of seeking to achieve the best possible solution (Silva, 2015; Souza & Dourado, 2015 as cited in Mendes et al., 2018). For these authors, the usage of PBL enables interdisciplinary vision for the development of critical and reflective discussions, in addition to the diversification of knowledge, learning exchange, and variety of opinions, comparisons, assessments based on social interaction, made viable with the development of group activities.

2.2 INTEGRATING BD/DA INTO ACCOUNTING TEACHING

There is a new stimulus for the accounting profession to introduce BD/DA in the exercise of its various activities, thus creating opportunities for educators to integrate such topics in accounting courses. Accounting firms and professional regulatory bodies recommend that big data, technology, and information systems be integrated into accounting courses to provide their students with the skills and knowledge needed to adapt to an

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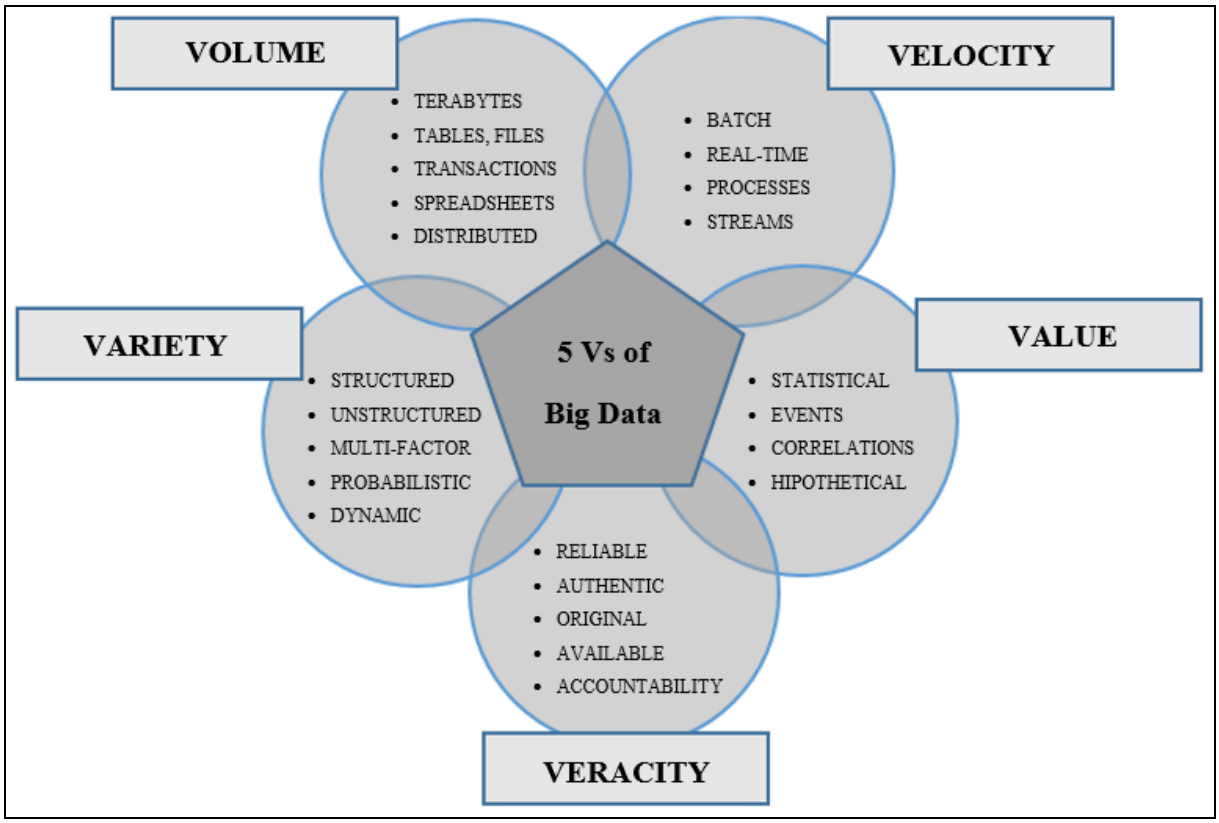
environment that is centered on a large volume of data (Sledgianowski, Gomaa, & Tan, 2017).

Big Data is essentially linked to an extremely large volume of datasets, which are generated by technological practices, such as social media, operational technologies, internet access and distributed information sources, being especially a practice that presents new opportunities for business (Taurion, 2013).

Companies can take advantage of any computational technique that generates information from data to transform a large set of data into useful information for decision making (Warren, Moffitt, & Byrnes, 2015). The main characteristics of BD can be summarized in the so-called 5 Vs: Volume, Velocity, Variety, Veracity, and Value, as reported in Figure 1.

Figure 1 5 Vs of Big Data



Source: Adapted from Demchenko et al. (2013, w/p)

Volume is the most important and specific feature of BD, imposing additional and specific requirements of all traditional technologies and tools currently used, tending to include data collections of all observed events, activities, and sensors, which has become

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possible and is important for Social Science activities (Demchenko, Grosso, de Laat, & Membrey, 2013). In the definition presented by the authors, the volume includes resources such as size, scale, quantity, data in the terabyte dimension and storage in individual files or databases, with the need to be accessible, searchable, processed, and manageable.

Another important feature of BD is that data is generated at high *velocity*, including data that is generated by sensor or multi-event arrays, with real-time processing, with batch shipments or as streams. In this regard, BD deals with another characteristic, which is the vast *variety* and complexity existing in large datasets, information, and semantic models, resulting in structured or unstructured, semi-structured and mixed data, imposing new storage requirements (Demchenko et al ., 2013).

According to Demchenko et al. (2013), the *value* is a key characteristic of the data, defined by the added value that the collected data can bring to the process, activity, or hypothesis, being directly related to its volume and variety. Regarding *veracity*, data must be reliable, authentic, and protected from unauthorized access and modification. Data must be protected throughout its lifecycle, that is, during its collection, processing on computers, and storage, so that it is reliable (Demchenko et al., 2013).

Based on these characteristics, the broad impacts of BD on the business environment can be observed, which may have a technical, managerial, and social nature. These impacts involve how technologies should be selected, how to reasonably limit the scope of analysis, how to examine the shift in privacy and security, and how to address cultural biases (Mckinney, Yoss II, & Snead, 2017). The growing importance of BD will significantly affect accounting, reflecting on how data is stored and recorded, how management uses the data to achieve organizational goals, and how reporting elements are processed and developed (Warren et al., 2015).

Given this scenario of innovation, ensuring that students can work with BD is becoming increasingly crucial. As an example, we highlight the Pathways Commission, formed by the American Institute of Certified Public Accountants (AICPA) and the American Accounting Association (AAA), whose objective is to examine the future of accounting higher education (Janvrin & Watson, 2017). In the recommendations of the Pathways Commission (2012, p. 72), it is highlighted that “many of these changes are dramatically reshaping the policies and processes of the profession. Yet these changes are usually not reflected in a robust timely fashion in academic accounting programs nor student’s internship

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experiences." Thus, it is imperative that accounting undergraduates have topics in their curriculum that include content and learning objectives associated with data analysis and information technology skills (Dzuranin, Jones, & Olvera, 2018).

This curriculum deficit creates a significant risk for students seeking training in accounting. In the current global environment, it is expected that in their professional journey they will be able to effectively use and understand the technologies and their capabilities, impacts, risks, and opportunities to add value to their organizations (Pathways Commission, 2012). We emphasize that, in this global context, accounting programs need to rapidly develop incentives, partnerships, and processes that identify and integrate current and emerging information and accounting technologies, so that the significant gap between academic instruction and professional practice be able to deliver on its value proposition (Pathways Commission, 2012).

3 METHODOLOGICAL PROCEDURES

This study is characterized as descriptive in terms of its objectives, as it sought to identify, from the perspective of accounting students, the contribution of active methodologies in teaching BD/DA. Regarding the approach, it is classified as quantitative, and we administered surveys as the data collection strategy.

The population of this study was 482 students enrolled in an undergraduate accounting program at a public higher education institution in Paraná, Brazil, at the beginning of the 2020 academic year. A BD/DA course was developed and offered optionally and was designed with the purpose of keeping students connected to their studies in the period of suspension from classes (March to June 2020) due to the COVID-19 pandemic, being an opportunity to work on content that was not traditionally taught in the regular courses of the bachelor's degree program and so complement student training.

The BD/DA course was offered to students free of charge, with the issuance of an eight-hour certificate that could be used to deduct from the 150 hours of Complementary Academic Activity (AAC) that they must meet. Students were invited via email to participate and 144 showed interest and registered for it. Of these 144 students, a sample of 137 answered the pre-course survey, which contained questions about sociodemographic information and self-reported knowledge. A post-course survey (n = 82) was administered as well. More details on the surveys are provided later on.

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The course consisted of the following topics: (i) Big Data and Data Analytics; (ii) Getting to know and installing Tableau software; (iii) Case Study (adapted from Hoelscher & Mortimer, 2018); and (iv) Closing. Among these course topics, the contents were developed using the active methodologies of the CM and DS.

In the "Big Data and Data Analytics" topic, we welcomed students and then provided them with the link to access the pre-course survey. After answering it, they watched a video prepared by the professor responsible for the course so that they could better understand the theoretical part of Big Data and Data Analytics. To achieve this step, students were submitted to a Quiz on Big Data and Data Analytics, consisting of three objective questions.

In the second topic, "Getting to know and installing Tableau software," students were given another video to understand better how Tableau worked before using it. In the following activity, students had an explanatory text and another video on installing the software on their computers. The Tableau software (www.tableau.com) was used in this research due to its (i) free license for use in the university environment, (ii) ease of use, which can be reached even with just a few hours of training (Igou & Coe, 2016; Nasu, Nogueira, Albertin & Marques, 2019), (iii) used by previous literature on the use of Big Data in accounting education (Hoelscher & Mortimer, 2018; Weirich et al., 2018; Igou & Coe, 2016; Kokina et al., 2017), and (iv) be considered one of the leading software on the market in the area of Business Intelligence and Analytics Software (Gartner, 2019). To use the Tableau software, there was no charge for students.

In the "Case Study" topic, we adapted and utilized the case from Hoelscher and Mortimer (2018). Students were asked to download its files (dataset in .xls and a text file in .pdf with instructions about the case). After downloading them, a video was made available in which the instructor started to explain the case, encouraging students to solve it in parallel, using Tableau. DS was used in this part of the course, where students were guided through the professor's instructions. Alternatively, this step could also be achieved by the student alone through the video and the text file that presented the path to the questions' solution (self-directed study). In this first part, it was simulated that the management of a company asked questions, to which the consultant (student's role) should answer. These questions were a tutorial on how to use Tableau, aimed at familiarizing students with it and its functionality.

After executing the initial commands and answering the questions with the help of the instructor, students needed to answer three more questions about the case analysis as part of

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the next step. This was when we utilized CM in conjunction with PBL. They developed the answers to these three questions autonomously, without the support of the instructor. However, they were allowed to talk to each other in order to have a better learning experience and assume more active participation in their education process. Finally, in the last topic, "Closing," students were asked to complete a post-course survey and were redirected to a "thank you" message at the end of it for having participated in the course and the research.

To perform data collection for this research, we used a pre- and a post-course survey, following prior literature (Hoelscher & Mortimer, 2018), Igou & Coe (2016), Kokina et al. (2017), and Rocha Neto, Silva, and Leal (2018)). The pre-course survey consisted of questions related to personal information and self-reported knowledge measures. A total of 137 students filled it in. The post-course survey, administered after completing the course, had questions structured in blocks: (i) self-reported questions about their data analysis software knowledge, (ii) degree of agreement on the use of data analysis software, and (iii) perceptions about active teaching methodologies. A total of 84 students filled it in.

For both surveys, we conducted a pilot test, and they were preceded by an informed consent form. For data analysis, we performed descriptive analysis and the following statistical tests: (i) paired samples Wilcoxon test; (ii) Friedman's test; and (iii) Cronbach's alpha coefficient. All analyses were performed using the R software (R Core Team, 2019). We indicate that, for some analyses, we used the 82 students who had completed the course and answered both the pre- and post-course surveys. In other analyses, the number of observations differs from these 84 students.

4 RESULTS

4.1 DESCRIPTIVE ANALYSIS

Table 1 shows the student's information. Most participants were first-year students (31.4%), who took night shift classes (56.2%), female (62.8%), and worked in the accounting area (43,1%). Students' average age was 22.6 years (standard deviation = 5.5 years; median = 21.0 years).

Table 2 reports the results of students' self-reported experience prior to the BD/DA course with respect to advanced knowledge of Excel and specialized data analysis software packages, such as Tableau and Power BI. Most of the students indicated that they had had a job or had been to a class that required advanced knowledge of Excel. This result is aligned

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with Kokina et al.'s (2017), who found that students possessed intermediate or advanced knowledge of Excel. The same cannot be said about advanced knowledge of data analysis software as the majority of students totally disagree (51.1%) or disagree (32.8%). This finding is consistent with the low incorporation of innovative technology resources into accounting courses.

Table 1 Student's information (n = 137)

Variable	Category	Frequency	%
Academic year	1º	43	31.4
	2º	36	26.3
	3º	35	25.5
	4º	23	16.8
Class shift	Night shift	77	56.2
	Morning shift	60	43.8
Gender	Male	50	36.5
	Female	86	62.8
	Other	1	0.7
Profession	Work/Internship in accounting	59	43.1
	Work/Internship in non-accounting	44	32.1
	Full-time student	34	24.8
Age	Mean = 22.6; Standard deviation = 5.5; Median = 21.0		

Table 2 Pre-course self-reported experience (n = 137)

Question	Answer options	Frequency	%
I have had a job or attended a class that required advanced knowledge in Excel.	Totally disagree	21	15.3
	Disagree	21	15.3
	Neutral	22	16.1
	Agree	45	32.8
	Totally agree	26	19.0
	I do not know	2	1.5
I have had a job or attended a class that required advanced knowledge in data analysis software packages (Tableau, Power BI, etc.)	Totally disagree	70	51.1
	Disagree	45	32.8
	Neutral	9	6.6
	Agree	4	2.9
	Totally agree	5	3.6
	I do not know	4	2.9

We observe that there are recommendations for accounting undergraduate programs to include learning experiences that develop skills and knowledge related to the integration of information technology, such as those issued by the Pathways Commission (2012) and the Association to Advance Collegiate Schools of Business (AACSB), in its A5 Standard (AACSB, 2018).

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4.2 PRE- AND POST-COURSE SURVEY RESULTS

Of the 144 accounting students enrolled in the course, 82 (56.9%) answered both the pre- and post-course surveys. This part of the survey was divided into three blocks. Block 1 asked students to estimate their level of knowledge about Excel (item 1.1), data visualization software (e.g., Tableau, Power BI, Qlik Sense, and others) (item 1.2), and statistical or data analysis advanced software packages (e.g., R, Minitab, SPSS, Stata, SAS, etc.) (item 1.3). Block 2 asked students to provide, on a scale from 1 point (totally disagree) to 5 points (totally agree), their level of agreement with the following questions: I know how data analytics can be used to answer important business questions (item 2.1), and I know how to use computer software to analyze large volumes of data, to identify correlations and develop algorithms to predict behavior (item 2.2).

Finally, using the same scale from block 2, block 3 asked students to answer to what degree they knew how to use data analysis software to connect data (item 3.1), visualize data (item 3.2), perform calculations (item 3.3), create statistics (item 3.4), create dashboards (item 3.5), create reports (item 3. 6), and create presentations (item 3.7). Pre- and post-course perceptions were compared using paired samples Wilcoxon test since Shapiro-Wilk's tests produced evidence that the distributions were not normal. Table 3 reports the results.

Students' pre- and post-course knowledge of Excel remained relatively the same. Their mean, SD, and median values are similar. Wilcoxon test also indicated no significant difference ($p > .05$). However, for items 1.2 and 1.3, students' perceived knowledge has increased relevantly ($p < .01$). Initially, their perceived knowledge was low (mean = 1.2; SD = 1.4; median = 4.0). After taking the course, it has significantly increased. Therefore, while students' perceived knowledge of Excel has remained the same, we found evidence to support that they have learned additional knowledge of data visualization and analysis software packages from the course classes.

Results from block 2 questions show that, in general, students have also improved their data analytical skills. Prior to the course, students reported an intermediate level of knowledge for item 2.1 (mean = 3.2; SD = 1.4; median = 4.0) and a low level for item 2.2 (mean = 1.8; SD = 0.9; median = 2,0). These perceived knowledge measures have significantly increased after the course, though. These findings suggest that the classes have contributed to student learning.

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Table 3 Pre- and post-course perceptions

Block 1: How do you estimate your knowledge level about:	**Pre-course**				**Post-course**			
	n	**Mean**	**SD**	**Median**	**n**	**Mean**	**SD**	**Median**
1.1 Excel	82	3.5	1.0	4.0	81	3.5	0.9	4.0
1.2 Tableau, Power BI, Qlik Sense, other data visualization software package***	81	1.2	0.5	1.0	81	2.4	0.8	2.0
1.3 Statistical or advanced analysis software packages (R, Minitab, SPSS, Stata, SAS, etc.)***	80	1.1	0.4	1.0	78	1.4	0.7	1.0
Block 2: Analyze the following items and report your agreement level:	**Pre-course**				**Post-course**			
	n	**Mean**	**SD**	**Median**	**n**	**Mean**	**SD**	**Median**
2.1 I know how data analytics can be used to answer important business questions***	81	3.2	1.4	4.0	79	4.2	0.7	4.0
2.2 I know how to use computer software to analyze large volumes of data, identify correlations, and develop algorithms to predict behavior***	79	1.8	0.9	2.0	80	3.3	0.9	3.0
Block 3: I know how to use data analysis software packages to:	**Pre-course**				**Post-course**			
	n	**Mean**	**SD**	**Median**	**n**	**Mean**	**SD**	**Median**
3.1 Connect data***	75	1.5	0.7	1.0	80	3.8	0.8	4.0
3.2 Visualize data***	75	1.7	0.9	1.0	80	4.0	0.7	4.0
3.3 Perform calculations***	75	1.6	0.9	1.0	80	3.6	0.9	4.0
3.4 Create statistics***	75	1.5	0.7	1.0	80	3.3	1.0	3.0
3.5 Create dashboards***	75	1.5	0.7	1.0	77	3.1	1.0	3.0
3.6 Create reports***	75	1.6	0.9	1.0	79	3.5	1.0	4.0
3.7 Create presentations***	74	1.6	0.9	1.0	79	3.3	1.1	3.0

Note. SD = Standard deviation. ***p < .01. The number of observations is not equal due to some missing values. When conducting the paired samples Wilcoxon tests, only students who had answered the pre- and post-course surveys were used.

Finally, block 3 results indicate that post-course perception is significantly higher than the pre-course one. It means that students' perceived learning has been improved in all seven criteria. We emphasize item 3.2, which is about data visualization skills. Since Tableau is a data visualization software, we expected that students would particularly enhance their skills at analyzing data visually. The results reported in Table 3 are consistent with prior literature. More specifically, Janvrin et al. (2014), Igou and Coe (2016), Kokina et al., (2017), Hoelscher and Mortimer (2018), Weirich et al. (2018), Nasu et al. (2019), Nogueira et al. (2020), and Cunningham and Stein (2018) have also found evidence that student knowledge of Big Data and Data Analytics was improved after studying (taking) a case (course) specifically designed to learn these topics.

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4.3 PERCEPTION ON ACTIVE METHODOLOGIES

Table 4 reports the results of students' perceptions on each active methodology employed in this study. In general, we observe that they have positively contributed to improving student learning and skills as the mean values are closer to five points.

Table 4 Students' perception about active methodologies

CM has contributed to... (Cronbach's alpha = .86)	**n**	**Mean**	**SD**	**Median**	**Minimum**	**Maximum**
improve my individual study skills	80	4.4	0.6	4.0	3.0	5.0
improve my data collection and analysis skills	80	4.4	0.5	4.0	3.0	5.0
improve my skill to design presentations	80	4.0	0.9	4.0	2.0	5.0
improve my practical skills	80	4.3	0.7	4.0	2.0	5.0
improve my skill of critical argumentation about business	80	3.9	0.8	4.0	2.0	5.0
utilize my knowledge acquired from other undergraduate courses	78	4.1	0.7	4.0	2.0	5.0
DS has contributed to... (Cronbach's alpha = .85)	**n**	**Mean**	**SD**	**Median**	**Minimum**	**Maximum**
improve my analytical skills	80	4.3	0.5	4.0	3.0	5.0
better organize. systematize. and consolidate my knowledge of data analysis	80	4.4	0.5	4.0	3.0	5.0
my individual problem solution skill	80	4.2	0.6	4.0	3.0	5.0
improve my own learning methods	79	4.1	0.7	4.0	2.0	5.0
the construction of interdisciplinary knowledge	77	4.2	0.7	4.0	2.0	5.0
my motivation to conclude the course	80	4.4	0.6	4.0	3.0	5.0
PBL has contributed to... (Cronbach's alpha = .88)	**n**	**Mean**	**SD**	**Median**	**Minimum**	**Maximum**
integrate my university knowledge with my business world knowledge	80	4.4	0.6	4.0	3.0	5.0
the construction of interdisciplinary knowledge	78	4.2	0.7	4.0	2.0	5.0
search for updated knowledge	79	4.3	0.6	4.0	3.0	5.0
stimulate my creativity	80	4.3	0.8	4.0	1.0	5.0
improve my ability to create projects	80	4.2	0.9	4.0	1.0	5.0
improve my business communication skill	80	3.9	0.8	4.0	1.0	5.0
create an efficacy learning environment	79	4.3	0.7	4.0	2.0	5.0

CM has particularly contributed to improving students' individual study and data collection and analysis skills since these items have obtained the highest mean values (4.4 points). Students also declared that CM was useful for improving their practical skills (mean = 4.3), as well as their critical argumentation skills, although with less intensity (mean = 3.9). When examining the minimum values, we noticed that there was at least one student who has actually disagreed that CM has provided a positive contribution to students' skill of designing presentations, practical skills, critical argumentation skills, and knowledge acquired from other courses (minimum = 2.0). This evidence suggests that there is still room for improving

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the use of CM within the BD/DA course. Despite that, the mean and median values support that students have had a positive learning experience overall.

DS has provided meaningful contributions to consolidate students' data analysis knowledge and motivation to conclude the course (mean = 4.4). DS was primarily employed in the initial part of the course to guide students through the utilization of Tableau. We think it would have been harder for students if there was not made any Tableau material available to them. Our concern was to provide explanatory resources about Tableau's functionality in order to encourage students to use it to solve data analysis problems throughout the course. These results suggest that we have been successful in this sense. DS has contributed to improving students' own learning techniques (mean = 4.1), however, at lower levels compared to the other DS items.

PBL has generated similar impressions. It was especially important to integrate students' academic knowledge with their business world, practical knowledge (mean = 4.4). PBL has motivated students to search for updated knowledge (mean = 4.3) and stimulated their creativity. When observing the minimum values, we note that there was at least one student who has totally disagreed that PBL had contributed to improving his/her creativity, project, and business communication skills (minimum = 1.0). There was also at least one student who has disagreed that it has created an efficacy learning environment (minimum = 2.0). We take these results as an opportunity to enhance the course in the future. They also represent aspects on which we can work to develop. PBL can be used in multiple manners, and it can certainly be used with a major focus on improving students' creativity, communication, and project skills.

We also calculated the Cronbach's alpha to examine the internal consistency of the items belonging to each active methodology. We found evidence that there is a high internal consistency among the items. Its acceptance level is usually higher than .8 (Smith, 2014). It suggests that, therefore, the items represent a good indication of students' general perception regarding CM, DS, and PBL.

As a supplementary analysis, we compared students' perceptions across active methodologies. We employed Friedman's test once the parametric test's assumptions were not met, which correspond to a non-parametric version of Analysis of Variance (ANOVA) for dependent observations. Table 5 reports the results.

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Table 5 Comparison of students' perception across active methodologies

Active methodology	Mean	SD	Median	p-value
CM	4.2	0.5	4.0	
DS	4.3	0.5	4.2	0.3507
PBL	4.2	0.5	4.1	

We noticed that the means and median values are similar across active methodologies. And according to Friedman's test result, there is no significant difference between the participants' perceptions. Therefore, we found evidence to suggest that students perceived the use of all three active methodologies similarly.

5 CONCLUDING REMARKS

Given the constant changes in the accounting profession in recent decades and the requirements and recommendations for accounting professionals (Pathways Comission, 2012; AACSB, 2018), whether in their academic training or professional activities, this work was developed with the purpose of examining the accounting students' perception on the use of active methodologies to teach BD/DA. We designed and implemented a specific course to teach these topics using CM, DS, and PBL.

Initially, we evaluated students' pre-course experience and knowledge of Excel and data visualization and analysis software packages. Consistent with findings from previous research, students reported to be familiar with Excel, but only a few had used data visualization and analysis software packages at their work or university. Students then took the BD/DA course and completed a post-course survey that allowed us to make comparisons between their pre-course- and post-course perceptions. When doing this analysis, we found that students' knowledge of Excel has remained the same, but their knowledge of BD/DA was significantly improved. In particular, we noticed relevant changes in students' ability to connect data, visualize data, and perform calculations.

Additional questions about active methodologies revealed that CM helped students advance their individual study and data collection and analysis skills. DS assisted them in enhancing their analytical skill and better organizing their data analysis knowledge. PBL also had a positive impact on students. It has especially contributed to integrating students' academic knowledge with their business world knowledge. Results from Cronbach's alpha analysis revealed that the items presented high internal consistency. It allows us to observe that the items were measuring the same thing (either related to CM, DS, or PBL). Finally,

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Friedman's test result indicated that students perceived all three active teaching methodologies in similar ways as no significant difference was detected.

Our findings have key implications for accounting education. First, it supports active learning practices as we were able to observe positive academic experiences, especially for students. Second, we show that research can and must be integrated into education since the case used here was adapted from a prior study (Hoelscher & Mortimer, 2018). There is also recent encouragement to incorporate accounting education research into education (Madsen, 2020). And third, because there was no relevant difference among students' perception across active methodologies, this study has shown that multiple teaching techniques can be employed satisfactorily in the same course. Each technique has its strengths and weaknesses. When combined, they may produce better learning outcomes.

We do acknowledge that this study presents some limitations. First, our findings are based on students' perceptions. No objective measure was analyzed. Since subjective measures might change due to situational cues or overtime, additional research is necessary to observe whether it generates consistent results. A second limitation regards the Brazilian literature on the usage of BD/DA in accounting education. Only a few studies were identified, and, consequently, some topics presented a more restricted discussion. We believe this point will become less concerning as this literature increases.

Active methodologies present a direct association with the process of transformation of pedagogical practice, leading students to comprehend educational objectives and the workplace demands from beyond theoretical aspects. Using new methodologies and resources in the teaching-learning process brings students closer to the challenges that will be encountered in their professional trajectory. Albeit students' data analysis knowledge still needs improvement, the BD/DA course provided its advancement and the basis for further development. We obtained promising evidence that faculty and academic managers can use to reflect on and implement such methodologies and resources in their respective accounting programs.

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[i] (Portuguese) "o método ativo propõe o movimento inverso, ou seja, passam a ser compreendidos como sujeitos históricos e, portanto, a assumir um papel ativo na aprendizagem, posto que têm suas experiências, saberes e opiniões valorizadas como ponto de partida para construção do conhecimento" (Diesel et al., 2017, p. 271).

[ii] (Portuguese) "a educação brasileira raramente vivenciou processos de inovação, uma vez que os modelos vivenciados na prática no território nacional tinham como base experiências de países europeus desenvolvidos economicamente" (Debald, 2020, p. 1).

[iii] (Portuguese) "as metodologias ativas dão ênfase ao papel protagonista do aluno, ao seu envolvimento direto, participativo e reflexivo em todas as etapas do processo, experimentando, desenhando, criando, com orientação do professor" (Bacich & Moran, 2018, p. 3).

[iv] (Portuguese) "estudantes e profissionais deixam o papel passivo e de meros receptores de informações, que lhes foi atribuído por tantos séculos na educação tradicional, para assumir um papel ativo e de protagonistas da própria aprendizagem" (Filatro & Cavalcanti, 2018, p. 18)

[v] (Portuguese) "para, examina, reflete, relaciona a sua história e passa a ressignificar suas descobertas" (Berbel, 2011, p. 29).

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[vi] (Portuguese) "são muitas as possibilidades de Metodologias Ativas, com potencial de levar os alunos a aprendizagens para a autonomia" (Berbel, 2011, p. 30).

[vii] (Portuguese) "levar os estudantes a refletirem sobre situações apresentadas no caso, podendo envolver a tomada de decisões sobre o episódio estudado" (Ikeda, Veludo-de-Oliveira, & Campomar, 2005, p. 142).

[viii] (Portuguese) "desperta nos alunos uma postura criativa, inovadora, crítica, para que possam se tornar sujeitos dinâmicos, responsáveis pela transformação e superação dos modelos obsoletos existentes em nossa realidade social" (Miranda, 2017, p. 92).

[ix] (Portuguese) "extrapolar o texto para a realidade vivida, compreender e interpretar os problemas propostos, sanar dificuldades de entendimentos e propor alternativas de solução; exercita no aluno a habilidade de escrever o que foi lido e interpretá-lo; prática dinâmica, criativa e crítica da leitura" (Berwig, Cunha, Teodoro & Colauto, 2013, p. 123).

[x] (Portuguese) "trata-se de uma atividade realizada pelos alunos, com roteiros de perguntas desenvolvidas previamente pelos professores" (Miranda, 2017, p. 79).