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Problem-Based Learning in the teaching of Statistics: a comparative and reflective analysis

Aprendizaje basado en problemas en la enseñanza de estadísticas: un análisis comparativo y reflexivo

Apprentissage basé sur les problèmes dans l'enseignement statistique : une analyse comparative et réfléchissante

Aprendizagem Baseada em Problemas no ensino de Estatística: uma análise comparativa e reflexiva

Mateus Augusto Ferreira Garcia Domingues[1]
Universidade Tecnológica Federal do Paraná - UTFPR
Doutorando do programa de Ensino de Ciência e Tecnologia - PPGECT
https://orcid.org/0000-0002-7023-7199

Guataçara dos Santos Junior[2]
Universidade Tecnológica Federal do Paraná - UTFPR
Doutorado em Ciências Geodésicas
https://orcid.org/0000-0002-6234-7961

Abstract

This article aims to make a comparative analysis of the active methodology Problem-Based Learning with the Traditional Method of Teaching, as an alternative for teaching statistics. This theoretical essay was conducted to discuss the characteristics of Problem-Based Learning for Statistics teaching, as well as the advantages in relation to the Traditional Method of teaching. The use of active methodologies, particularly the one adopted here, can achieve educational goals and empower students for the demands and changes of contemporary society. This is due to the fact that by investigating and solving problems of the Problem-Based Learning teaching methodology, students can develop skills and social skills, becoming active agents of their learning. Thus, the PBL teaching methodology can offer significant benefits to Statistical Education. By promoting active learning, developing cognitive skills, integrating theory and practice, empowering for citizenship and offering practical guidelines, the PBL teaching methodology can transform how statistics is taught and learned, preparing students for the challenges of contemporary society.

[1] mateusdomigues@alunos.utfpr.edu.br
[2] guata@utfpr.edu.br

Keywords: Active methodology, Problem-based learning, Traditional teaching, Statistics education.

Resumen

El presente artículo tiene como objetivo hacer un análisis comparativo de la metodología activa Aprendizaje Basado en Problemas con el Método Tradicional de Enseñanza, como alternativa a la enseñanza de Estadística. Este ensayo teórico se realizó para discutir las características del Aprendizaje Basado en Problemas para la enseñanza de Estadística, así como las ventajas respecto al Método Tradicional de enseñanza. El uso de metodologías activas, particularmente la aquí adoptada, puede alcanzar los objetivos educativos y capacitar a los estudiantes para las demandas y cambios de la sociedad contemporánea. Esto se debe al hecho de que, al investigar y resolver problemas de la metodología de enseñanza del Aprendizaje Basado en Problemas, los estudiantes pueden desarrollar habilidades sociales y habilidades, convirtiéndose en agentes activos de su aprendizaje. Por lo tanto, la metodología de enseñanza ABP puede ofrecer beneficios significativos para la educación estadística. Al promover el aprendizaje activo, desarrollar habilidades cognitivas, integrar la teoría y la práctica, capacitar para la ciudadanía y ofrecer directrices prácticas, la metodología de enseñanza ABP puede transformar la forma en que se enseña y aprende estadística, preparar a los estudiantes para los desafíos de la sociedad contemporánea.

Palabras clave: Metodología activa, Aprendizaje basado en problemas, Enseñanza tradicional, Educación estadística.

Résumé

Le présent article a pour but de faire une analyse comparative de la méthodologie active d'apprentissage basé sur les problèmes avec la méthode traditionnelle d'enseignement, comme alternative à l'enseignement des statistiques. Cet essai théorique a été réalisé pour discuter des caractéristiques de l'apprentissage basé sur les problèmes pour l'enseignement des statistiques, ainsi que les avantages par rapport à la méthode traditionnelle d'enseignement. L'utilisation de méthodologies actives, en particulier celle adoptée ici, peut atteindre les objectifs éducatifs et permettre aux étudiants d'être à la hauteur des exigences et des changements de la société contemporaine. Cela est dû au fait que, en étudiant et en résolvant les problèmes de la méthodologie d'enseignement de l'apprentissage basé sur les problèmes, les étudiants peuvent développer des compétences et des aptitudes sociales, devenant ainsi des agents actifs de leur apprentissage. Ainsi, la méthodologie d'enseignement ABP peut offrir des avantages

significatifs pour l'éducation statistique. En favorisant l'apprentissage actif, en développant les compétences cognitives, en intégrant la théorie et la pratique, en donnant des compétences à la citoyenneté et en fournissant des directives pratiques, la méthodologie d'enseignement ABP peut transformer la façon dont les statistiques sont enseignées et apprises, préparer les étudiants aux défis de la société contemporaine.

Mots-clés : Méthodologie active, Apprentissage axé sur les problèmes, Enseignement traditionnel, Éducation statistique.

Resumo

O presente artigo tem como objetivo fazer faz uma análise comparativa da metodologia ativa Aprendizagem Baseada em Problemas com o Método Tradicional de Ensino, como uma alternativa para o ensino de Estatística. Este ensaio teórico foi realizado para discutir as características da Aprendizagem Baseada em Problemas para o ensino de Estatística, bem como as vantagens em relação ao Método Tradicional de ensino. A utilização de metodologias ativas, particularmente a aqui adotada, pode atingir os objetivos educacionais e capacitar os estudantes para as demandas e mudanças da sociedade contemporânea. Isso se deve ao fato de que, ao investigar e resolver problemas da metodologia de ensino Aprendizagem Baseada em Problemas, os alunos podem desenvolver competências e habilidades sociais, tornando-se agentes ativos de sua aprendizagem. Sendo assim, a metodologia de ensino ABP pode oferecer benefícios significativos para a Educação Estatística. Ao promover uma aprendizagem ativa, desenvolver competências cognitivas, integrar teoria e prática, capacitar para a cidadania e oferecer diretrizes práticas, a metodologia de ensino ABP pode transformar a forma como a Estatística é ensinada e aprendida, preparando os estudantes para os desafios da sociedade contemporânea.

Palavras-chave: Metodologia ativa, Aprendizagem baseada em problemas, Ensino tradicional, Ensino de estatística.

Problem-Based Learning in Statistics teaching: a comparative and reflective analysis

The study and application of active learning methodologies requires the implementation of innovative classes[3] that aim to support the teaching and learning process. In this way, they allow students to build their conceptual understanding through contextualized situations, thus contributing to the active construction of their learning. When adopting an approach focused on active methodologies, pedagogical practice should encourage challenging activities to promote critical and reflective education (Lima et al., 2021).

Based on this assumption, one of the greatest challenges that education has faced in recent years is to make people keep up with the development of society (Sousa, 2010; Souza & Dourado, 2015), transforming them into critical citizens on issues related to the economy, politics, psychology, and the arts. Therefore, schools and universities must encourage these young people to engage with social, economic and technological issues (Berbel, 1998; De Bortoli et al., 2020; Silveira et al., 2020) in order to lead an honorable life centered on their well-being, regardless of their social class.

In light of the above, a teaching methodology that allows students to develop their understanding as members of this society can contribute significantly to this educational challenge. Students are expected to recognize that society is constantly evolving, which allows them to apply their theoretical knowledge in real situations.

Social presence is a relevant feature in statistics education that can be seen in active learning, which promotes collaborative learning through problem-solving. During teamwork, students interact with each other and with the professor, resulting in active learning. Active learning also allows students to discover, construct, and understand statistical ideas and model statistical thinking (Silva & Schimiguel, 2016).

According to Lima et al. (2021), the use of active methods in the teaching and learning process allows students to be active subjects in the construction of their knowledge and the professor to facilitate learning. Therefore, teachers need to develop strategies that inspire and challenge students to meet the fundamental needs of contemporary society (De Godoi et al., 2020).

In light of the above, this article aims to provide a comparative analysis of the active Problem-Based Learning methodology with the traditional teaching method as an alternative

[3] In this context, the term innovative refers to the use of active methods such as problem-based learning, projects, flipped classroom, team, gamification and design thinking.

for teaching statistics. In other words, Problem-Based Learning (PBL), compared to the traditional teaching method, can be a methodological option that helps students to become actively involved in learning statistics.

The active learning methodology

Education must adapt to the increasingly technological world. To do this, it is possible to use problem-solving, encouraging creativity, critical reflection, communication, and innovation (Barbosa & Moura, 2013; Oliveira et al., 2020; Sousa, 2010). According to Moran (2015), the educational process needs to take a didactic approach in such a way that those in the school environment can learn to build their own life projects and become critical subjects. This idea suggests that active methodologies can be used to develop new practices that put students at the center of learning.

Active methodology consists of a teaching practice that results in active learning. In this context, emphasis is placed on the student, who actively engages in their learning, thus favoring the processing of information (Barbosa & Moura, 2013). These subjects will have to assume an active position in the construction of their knowledge, based on a problematizing pedagogy (Paiva *et al.*, 2016).

There are many opportunities to develop active methodologies, and these can be found in the literature (Barbosa & Moura, 2013; Diesel et al., 2017; Moran, 2018, 2015; Paiva et al., 2016). With regard to this research, the emphasis is on the teaching methodology Problem-Based Learning (PBL)[4], which has different approaches that can stimulate students in the development of their learning, enabling them to be more autonomous and impetuous when compared to the traditional teaching model.

Problem-Based Learning

PBL is a teaching methodology developed by Maastricht University in the Netherlands and implemented at McMaster University School of Medicine in Hamilton, a port city in the Canadian province of Ontario. It is a teaching and learning methodology with social and professional implications based on real problems (Borochovicius & Tortella, 2014; Sousa, 2010; Souza & Dourado, 2015).

[4] Problem-Based Learning (PBL) will be considered as a teaching methodology in this study, as it is a systematic teaching and learning approach that offers students the opportunity to acquire knowledge, skills and competencies through investigative activities that simulate real-world problems.

The PBL teaching system uses problems to motivate students to construct their knowledge (Berbel, 1988; Lopes et al., 2019; Souza & Dourado, 2015), stimulating the development of creativity and criticality. In this way, the use of this teaching method contributes to the development of knowledge and the management of learning through real problems.

Thus, PBL is a teaching and learning methodology that emphasizes the construction of students' knowledge through problem-solving. Students are at the center of the teaching and learning process as they are encouraged to construct their knowledge, with the professor as the learning mediator/guide, that is, the facilitator who gives instructions, directs instruction, and provides application opportunities for the development of critical, reflective, and creative thinking skills.

According to Moran (2018), the PBL teaching methodology is based on the active learning approach, where the student is the focus of the teaching and learning process. In addition, students are prepared to face challenges and solve problems that may be related to everyday issues or to their future profession. Therefore, the proposed problems must be related to the lives of the students, because from this connection, collaboration is valued, which stimulates the exchange of knowledge and ideas among them (Silva & Schimiguel, 2016).

The PBL teaching methodology promotes the development of critical thinking and reflection on problem-solving (Malheiro & Diniz, 2008). This methodology prepares students by integrating theory and practice, allowing them to develop strategies to find solutions to current problems.

In this sense, the PBL teaching methodology encourages dialogue and creativity, contributing to the holistic development of individuals. When they are challenged to find solutions to problems, they practice skills that are fundamental to the progress of citizenship. Therefore, the PBL teaching methodology can provide students with meaningful and transformative learning that prepares them to face the challenges of today's world.

Some higher education institutions use this methodology as part of their curriculum, especially in medical courses (Aquilante et al., 2011; Lopes et al., 2019; Malheiro & Diniz, 2008; Sousa, 2010; Souza & Dourado, 2015). Gradually, it is also being incorporated into basic education (Almeida & Macêdo, 2018; Borochovicius & Tassoni, 2021; De Godoi et al., 2020; Malheiro & Diniz, 2008). Its implementation, in any structured course, requires a change in the professor's attitude (De Godoi et al., 2020), since in disciplinary training, what still prevails are classes in which the teacher is the center of the transmission of knowledge, this is the model that has been maintained (Tangerino, 2017).

The PBL teaching methodology can be applied to all fields of knowledge, such as Applied Human and Social Sciences, Natural Sciences, Languages, Mathematics and its technologies. According to Souza (2016) and De Godoi et al. (2020), it has shown significant learning outcomes, whether in graduate or postgraduate courses or in basic education.

Hung (2016) shows great admiration for this teaching method and believes in its potential. He argues that the PBL teaching methodology can be useful in developing problem-solving skills and critical thinking. In addition, he argues that the PBL teaching methodology can be used to help students construct their knowledge and develop life skills, such as self-reflection and decision-making.

Therefore, the PBL teaching methodology involves students in the inquiry process, using problems to stimulate the critical and reflective sense of contemporary people (also known as Generation Z, Y and Millennials [1]). In other words, individuals who have developed through technological advances are surrounded by information from all over the world, which directly affects their personal and professional lives (Borochovicius & Tortella, 2014).

In the ABP teaching methodology, the professor acts as a mediator and facilitator of learning at all stages. Students are responsible for making discoveries about specific skills and developing their knowledge based on the entire investigative process (Frei, 2020).

[Millennials, also known as Generation Z and Y or the Internet Generation, refers to the generation of people born between 1980 and 2020. They were the first to use the Internet as a means of communication and access to information. People in this generation are characterized as highly connected, instantaneous, independent, multitasking, and more open to change than previous generations. They are also considered digital and responsible than other generations and more likely to research before making decisions (Palfrey & Gasser, 2011; Veras, 2011).

Comparison between Problem-Based Learning and the traditional teaching method

According to Lopes et al. (2019), traditional teaching and the PBL teaching methodology are at opposite ends of the spectrum. The latter encourages students to participate in research in a specific context, making them part of the dynamic of teaching and learning, with the professor acting as a mediator of knowledge. The former focuses too much on the acquisition of information, with little critical content or theoretical depth. This can lead to superficial learning, where students can memorize content without understanding the real application of this knowledge or developing critical analysis and reflection skills.

In the traditional teaching method, the professor is considered the active subject of the teaching-learning process, usually imparting his or her knowledge through lectures. In this

method of teaching, the professor has the power to determine what is taught and how it is taught. Although beneficial to the professor, the traditional teaching method can be detrimental to students, especially when the teacher is unable to explain the relationship between theory and practice, making it difficult to understand how this knowledge applies to everyday life (Krüger & Ensslin, 2013; Leão, 1999).

In the ABP teaching methodology, the professor is the teacher who presents the problem and guides the students according to their needs. The student plays an active role in the educational process, as he is the researcher responsible for finding a solution, but to do so, he must be involved in the problem situation and develop strategies that contribute to its solution (Ferrarini et al., 2019; Lopes et al., 2019; Moran, 2018, 2015; Souza & Dourado, 2015).

The ABP teaching methodology aims to make students the protagonists of their learning, as today's society demands new skills that traditional schools are often unable to provide. It uses a teaching method in which the professor directs the teaching and is the holder of knowledge (Lopes et al., 2019). In this environment, students are simple listeners, passive recipients of information organized and presented by the professor.

However, Freire (1994) argues that traditional education based on the banking model must be replaced by a methodology that promotes student learning by involving them in problematized situations. According to Freire (1987), problematizing education should replace the failed traditional teaching system by allowing students to have critical insights into reality, stimulating creativity, reflection, and action in the world.

Despite the potential of the PBL teaching method, the one that prevails in schools and universities is the one that focuses on the professor, i.e., the bank teaching, which reduces the dialogue because the professor has great control over what is said in the classroom. The teacher is the one who utters the words, while the students listen passively (Brighente & Mesquida, 2016; Freire, 1974).

Table 1 provides an overview of the main differences between these two models, emphasizing the importance of promoting more active and meaningful learning for students (Garcia, 2014).

Table 1.

Comparison of the Traditional Teaching Model and Problem-Based Learning (Adapted from Garcia, 2014)

Traditional Method	**Problem-Based Learning**

With the professor at the center of the process	The student is at the center of the process
Rational and linear	Coherent and relevant
Organized from the part to the whole	Organized from the whole to the part
Professor is the transmitter	The professor is the learning guide, i.e. the facilitator
Learning is receiving	Learning is building
Structured environment	Flexible environment

The traditional teaching method is an educational process in which the professor is the center of all actions. It is guided by rational and linear values of approach to learning, where basic concepts are taught first and then topics are explored in greater depth (from the part to the whole). The professor's job is to explain the content logically, first getting rid of the general concepts and then focusing on the details. The environment is hierarchical and controlled, with the professor as the teaching figure, as well as the students, listeners, and learners.

The ABP teaching method, as an educational methodology, provides a transition from passive, banking-style education to active education where it is possible to take responsibility for what is learned. In traditional education, the professor explains a certain topic and then gives the students a task to apply the acquired knowledge. The ABP teaching methodology makes learning more coherent and relevant because activities are organized around problems, encouraging students to build their knowledge. As such, it provides a means for students to improve their skills and apply them to solve social and professional problems (Barco Rojas, 2021).

By adopting PBL as a methodological proposal, students can create different ways of overcoming social subordination. This is an opportunity to stimulate and enable conceptual renewal. In this way, students can discover and strengthen their own identities and use them to confront the exploitation imposed by the outside world.

According to Freire (1987), in order to have an education that promotes freedom, it is necessary to have a pedagogy that liberates, in which individuals are able to configure their learning not as a pedagogy for them, but for themselves. The practice of freedom finds its proper expression only in a curriculum that allows students to discover/rediscover their critical capacities and to succeed as subjects of their own historical destiny.

In this sense, PBL is a teaching method with potential, since it allows students not only to have different perspectives on problems close to their context, but also to gather information from the outside world (real situations) in order to draw their own critical conclusions, formalizing their identity through a re-signification based on lived experience. The ABP teaching methodology, when used to develop basic competencies and skills in a variety of contexts, helps students to become more independent in their learning.

Challenges and possibilities in teaching statistics

The teaching of statistics is widely debated in the educational field, since this area of knowledge has a great impact on the training of critical citizens to deal with information in different areas of society. However, there is a challenge in promoting effective learning in this area, which is related to the need to implement teaching strategies that involve the active participation of students (Schreiber & Porciúncula, 2021). According to Cazorla et al. (2022), the main challenge for statistics educators is to develop teaching strategies that motivate students to act effectively as critical, creative, and reflective citizens.

Given this scenario, Schreiber and Porciúncula (2021) emphasize the importance of adopting teaching strategies and/or methodologies that support students' participation in the construction of their learning, such as proposing research projects, experimental activities, problem-solving, and the use of technology. In this way, statistical learning can be enriched and made more meaningful in their eyes.

Pereira (2022) points out that the use of simulators and applications, as well as the production of scientific research, can be effective in overcoming the challenges associated with teaching statistics. By incorporating these practices, professors can provide more dynamic and engaging learning, as well as stimulate critical thinking and autonomy in the teaching and learning process.

Therefore, the use of innovative pedagogical strategies is extremely important for the successful teaching of statistics. These approaches need to be adapted and developed for the school context in order to engage students and make the teaching of statistics more attractive and relevant to these young people, so that they understand the relevance of this area of knowledge for their academic and professional training.

According to Pereira (2022), the difficulties and gaps encountered can be overcome with pedagogical practices that provide students with a better understanding of the concepts and their practical applications. Communication, problem-solving, and scientific research software allow the exchange of information and discussion between professors and students on the topics covered. In addition, group work encourages collaboration among students and reinforces meaningful learning.

The elements mentioned make it possible to understand the knowledge built up in real situations, but it is essential that professors pay attention to pedagogical strategies in order to contribute to the teaching of statistics. To this end, they should always seek an active and dynamic approach in order to make learning more effective and meaningful.

In this sense, educational initiatives must meet the needs of today's society. They should be based on an interdisciplinary, participatory approach and focus on empowering students, with the aim of preparing them to face challenges and make a significant contribution to building a more just and sustainable society (Cazorla et al., 2022).

Rethinking the teaching of Statistics: Problem-Based Learning compared to the traditional teaching method

When comparing the ABP teaching methodology with the traditional teaching method, the literature indicates that the ABP teaching methodology offers more learning opportunities, since banking education is based only on the deposit and transfer of values and knowledge from "professor to student" and fragments reality, i.e., concepts are approached abstractly in relation to the context and reality of the students. The dominant model of education promotes uniformity, devalues and eliminates the creative abilities of students, and does not contribute to the development of critical thinking.

In this way, it is possible to identify some relevant differences that can affect the effectiveness of teaching statistics. In the ABP teaching methodology, students are placed at the center of learning and are encouraged to investigate and solve real problems, which promotes autonomy, critical thinking, and practical application of knowledge (Spada, 2019). In traditional teaching, the professor passively transmits knowledge to students, which can limit active participation and practical understanding of concepts (Garcia, 2014).

The studies of Schreiber and Porciúncula (2021) and Pereira (2022) are related to the characteristics and principles of the PBL teaching methodology, which can contribute to overcoming the challenges of teaching statistics. It allows students to analyze problems and stimulate the development of fundamental skills to understand and apply statistical concepts in actual situations (Silva & Schimiguel, 2016). Studies by Anasagasti and Berciano (2016), Darmawan and Hidayah (2017), and Rodríguez-Villalobos et al. (2020) support this statement.

Anasagasti and Berciano (2016) point out that when comparing the PBL teaching methodology with traditional methods used in probability and statistics for future undergraduate

professors, it can be seen that the former promotes active and collaborative learning. This is crucial for the training of future professors, as it not only develops technical mastery, but also improves communication skills and critical reflection on teaching practice.

Darmawan and Hidayah (2017) investigate the effectiveness of a student-centered learning method, supported by the ABP teaching methodology, to improve learning outcomes in industrial statistics courses. The study shows that the implementation of the PBL teaching methodology not only improved academic outcomes, but also provided an active and collaborative learning environment.

Rodríguez-Villalobos et al. (2020) developed the study to evaluate the effectiveness of the PBL teaching methodology in a probability and descriptive statistics course. Although some students had difficulty adapting, the experience provided valuable insights into its application, suggesting that this proposal may be promising, but requires adjustments and monitoring to maximize its impact.

In summary, the PBL teaching method can be effective in promoting active, collaborative, and meaningful learning in statistics courses. As such, it can both improve understanding of statistical concepts and promote important skills such as critical thinking, communication, problem-solving, and teamwork.

Thus, the use of PBL teaching methodology can create conditions that stimulate informed decision-making and encourage students to search for information that helps build statistical knowledge. According to Vidic (2007), it can contribute significantly to the teaching of statistics, provided that it is carefully planned, taking into account the specificities of the problems to be worked on and the impact they can have on the teaching and learning process.

Frei (2020) used the PBL teaching methodology to contribute to the teaching of statistics, using the stages shown in Table 2. These steps help to develop critical and analytical skills, as well as to promote a deeper understanding of statistical concepts.

Table 2.

Steps to implement the PBL teaching methodology (Adapted from Frei, 2020)

Stages	Paths to follow
Identifying the problem	Select an ill-structured and relevant problem that students can investigate. The problem should be challenging and related to real-world situations, allowing statistical concepts to be applied.
Group formation	Divide students into small groups to promote collaboration. Group work is essential for exchanging ideas and building knowledge collectively.
Research and data collection	Encourage students to research relevant information about the problem, collect data and use different sources of information. This stage is crucial for developing research and analysis skills.
Analysis and interpretation	Have the groups analyze the data collected, apply appropriate statistical techniques and interpret the results. This stage involves the practical application of the statistical concepts learned.
Discussion and reflection	Promote group discussions on the proposed solutions, allowing students to reflect on their learning and the different approaches to solving the problem.
Presentation of results	Ask the students to present their conclusions and solutions to the class, which helps to develop communication and argumentation skills.
Evaluation	Carry out formative assessment that takes into account not only the final result, but also learning, student participation and group collaboration.

Thus, by following the steps described in Table 2, the PBL teaching methodology aims to promote active participation, contextualization of content, development of basic skills, and practical application of statistical knowledge, preparing students to act competently and critically in today's society (Frei, 2020). Therefore, its use can contribute to the development of active learning, which confirms the statements of Schreiber and Porciúncula (2021) and Pereira (2022) regarding the need to implement pedagogical strategies that involve the active participation of students.

Traditional teaching, on the other hand, can have limitations in promoting the practical application of statistical concepts, which hinders students' understanding and relevance of statistics. Thus, active methods can encourage students to take a critical and reflective view of statistical data. Therefore, statistics education taught using active methodologies can have a significant impact on people's lives, as it prepares them to develop skills such as literacy, reasoning, and statistical thinking (Perin, 2019; Perin & Campos, 2020, 2022). Traditional education, based on the banking model, must be replaced by a methodology that prioritizes students' learning by involving them in problematized situations (Freire, 1994).

According to Bland (2004), the use of the ABP teaching methodology for working with statistics has advantages over the traditional method because it gives students a broader

understanding of statistics. This allows them to devote more time to the theoretical part, since each topic covered in class is explored through problems close to its context.

Based on these considerations, the ABP teaching methodology seems to have potential for teaching statistics. It favors the active participation of students, the practical application of concepts and the development of skills needed to deal with data and statistical information in a meaningful way (Pereira, 2022; Schreiber & Porciúncula, 2021), which can contribute to the development of literacy, reasoning and statistical thinking (Perin & Campos, 2020).

Education is currently facing several challenges, such as the need to prepare students for a constantly changing world, to develop autonomy and critical thinking, and to ensure the relevance and applicability of the knowledge acquired. Given this scenario, Malheiro and Diniz (2008) and Souza and Dourado (2015) point out that the perspective advocated here, in addition to developing critical thinking and reflection, allows students to reflect on the integration of theory and practice in order to find solutions not only to school problems, but also to current social problems.

Therefore, this methodology presents itself as a relevant and effective alternative to address these contemporary challenges in education by engaging students in a meaningful and active learning process. This favors the formation of critical, autonomous individuals capable of facing the demands of today's society, as can be seen in the following topics:

1. **Preparation for a constantly changing world**: The ABP teaching methodology encourages students to learn from their experiences in terms of solving problems and adapting to new situations, preparing them to deal with uncertainty and the rapid evolution of today's world (Silva & Schimiguel, 2016).
2. **Foster autonomy and critical thinking**: By involving students in the learning process with the aforementioned methodology, they are encouraged to develop autonomy, creativity, and critical thinking, which are fundamental skills for making decisions and solving problems independently (Barbosa & Moura, 2013; Moran, 2015; Oliveira et al., 2020; Sousa, 2010).

3. **Relevance and applicability of knowledge**: Active methodologies provide learning based on real, contextualized and challenging situations, which makes knowledge more relevant and applicable in reality, allowing people to face the challenges of today's society (Lima et al., 2021).
4. **Student engagement and motivation**: Active methodologies, such as the PBL teaching methodology, promote active student participation, group work, experimentation, and problem-solving, making learning more dynamic, engaging, and motivating, which can increase student interest and commitment (Lima et al., 2021; Moran, 2015; Silva & Schimiguel, 2016).

By adopting the PBL teaching methodology, it is possible to foster an educational environment that values innovation, collaboration, and social responsibility. Schools and universities can contribute significantly to empowering young people to face today's social, economic, and technological challenges and to become agents of change in their community/society. In this way, it is possible to contribute to statistics education that promotes students' empowerment and social engagement, enabling them to critically analyze information, make informed decisions, engage in social issues, and exercise active and responsible citizenship (Cazorla et al., 2022).

Given the importance of active student participation in problem-solving and the stimulation of critical thinking in statistics education, the ABP teaching methodology stands out. It allows students to apply statistical concepts in real-life situations, which helps them to understand topics more deeply, improve their analytical skills, and approach statistical questions in an autonomous and meaningful way (Frei, 2020; Silva & Schimiguel, 2016). As such, it has the potential for teaching statistics as it engages students in problem-solving, promotes knowledge construction in a contextualized way, and makes the subject more relevant to students.

Final considerations

The BPL teaching methodology appears to be promising for the teaching of Statistics, since it allows individuals to be trained to have a reflective, critical perspective and to be able

to face the challenges of modern society. Compared to traditional teaching, it has significant potential to promote more effective and relevant learning, resulting in the formation of more competent and critical citizens.

In view of this, its adoption in the teaching of statistics could be a possibility for achieving educational objectives and preparing students for the demands and changes, that today's society requires. This is because, by investigating and finding solutions to real problems, they develop their skills and abilities, acting as active beings capable of building their statistical knowledge.

As such, the PBL teaching methodology has potential and brings significant benefits to Statistics Education. Below are some points that highlight this innovation and the benefits associated with it:

a) **Educational Paradigm Shift:** Criticizes the traditional teaching model characterized by a passive approach in which the professor is the holder of knowledge and the students are mere receptors. It places students at the center of the teaching and learning process and promotes an active and participatory approach. This paradigm shift is innovative because it challenges established norms and encourages students to participate more meaningfully in the construction of their knowledge.

b) **Development of cognitive skills**: It has the potential not only to teach statistical concepts but also to develop cognitive skills such as analytical thinking, critical thinking, problem-solving, and creativity. These skills are fundamental in today's world, where the ability to interpret data and make informed decisions is increasingly valued.

c) **Integration of theory and practice**: By emphasizing the importance of establishing a link between theory and practice, an aspect that is often neglected in traditional teaching, the methodology discussed here allows students to apply statistical concepts in real situations, making learning more relevant and contextualized. This integration can increase student motivation and facilitate the retention of statistical knowledge

d) **Education for critical citizenship**: This innovative aspect goes beyond the teaching of statistics. By enabling students to analyze information, this teaching method can contribute to creating citizens who not only understand statistics, but also use this knowledge

to positively influence their communities/society. This is particularly important in a context where statistical literacy is fundamental for active participation in society.

e) **Practical guidelines for educators:** By offering practical guidelines for applying the PBL teaching methodology in classrooms, this practical approach is innovative in that it provides educators with concrete tools to modify their pedagogical practices. Providing resources and strategies for adopting the PBL teaching methodology can facilitate its implementation and increase adherence on the part of professors.

Against this background, the integration of the PBL teaching methodology can offer significant advantages for statistics education. By promoting active learning, developing critical skills, integrating theory and practice, training for citizenship, and providing practical guidelines, the PBL teaching methodology can transform the way statistics is taught and learned and prepare students for the challenges of contemporary society.

In this way, the PBL teaching methodology can effectively overcome the limitations of traditional teaching and provide a more dynamic, participatory and applicable approach to statistical content. It should be developed according to the school context, with the aim of involving students in the construction of knowledge and making learning more relevant to academic, personal and professional training. Therefore, it has the potential to help students in the teaching and learning process, encouraging critical thinking, creativity, autonomy and social responsibility, as well as the use of basic skills and competences for personal and professional life.

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