Learning styles and PEUS: possibilities for meaningful learning in upper secondary technical education

ARTICLE

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Abstract
Strategic preparation of activities proposed by the teacher is fundamental, as it involves learning styles and directly impacts the teaching-learning process. Based on a Scientific Initiation project, this research uses Ausubel's Theory of Meaningful Learning, Moreira's Critical Meaningful Learning, and the proposal of the Potentially Meaningful Teaching Unit (PMTU), adapted to the styles identified by the CHAEA questionnaire: active, reflective, theoretical, and pragmatic. Using bibliographic and explanatory methodology, principles such as progressive differentiation and integrative reconciliation are explored, in addition to models of pedagogical differentiation, including Honey-Alonso, Kolb, and VARK. It is expected that the adaptation of the PMTU to different learning styles will favor more inclusive and effective pedagogical practices in Technical Education, promoting greater student engagement and meaningful learning. Thus, the article discusses the importance of understanding learning styles for more effective education in Secondary Level Technical Education
Keywords: Meaningful Learning. Learning Styles. Technical Education. Pedagogical Planning. Scientific Initiation.

Estilos de aprendizagem e UEPS: possibilidades para aprendizagem significativa no ensino técnico de nível médio

Resumo
A preparação estratégica das atividades propostas pelo docente é fundamental, pois envolve os estilos de aprendizagem e impacta diretamente o processo ensino-aprendizagem. Com base em um projeto de Iniciação Científica, esta pesquisa utiliza a Teoria da Aprendizagem Significativa de Ausubel, a Aprendizagem Significativa Crítica de Moreira e a proposta da Unidade de Ensino Potencialmente Significativa (UEPS), adaptada aos estilos identificados pelo questionário CHAEA: ativo, reflexivo, teórico e pragmático. A partir de metodologia bibliográfica e explicativa, são explorados princípios como diferenciação progressiva e reconciliação integrativa, além de modelos de diferenciação pedagógica, incluindo Honey-Alonso, Kolb e VARK. Espera-se que a adaptação

da UEPS aos diferentes estilos de aprendizagem favoreça práticas pedagógicas mais inclusivas e eficazes no Ensino Técnico, promovendo maior engajamento estudantil e aprendizagem significativa. Assim, o artigo discute a importância de compreender os estilos de aprendizagem para uma educação mais efetiva no Ensino Técnico de Nível Médio.
Palavras-chave: Aprendizagem Significativa. Estilos de Aprendizagem. Ensino Técnico. Planejamento Pedagógico. Iniciação Científica.

1 Introduction

Understanding students' learning styles is essential to promote more effective and meaningful education. Each learner presents distinct ways of perceiving and assimilating information, which directly influence the construction of new knowledge. Recognizing these differences allows teachers to plan instructional strategies that are more closely aligned with the needs of the group, fostering motivation, engagement, and the strengthening of knowledge.

The Theory of Meaningful Learning, proposed by Ausubel (1968, 2000) and further developed by Novak (1984) and Moreira and Massini (2009), emphasizes the importance of integrating new content with prior knowledge, using subsumers as anchoring points for new information. To support this integration, Moreira (2011) proposed the Potentially Meaningful Teaching Unit (PMTU), a structured instructional sequence designed to promote deeper and more lasting learning.

Despite the widespread use of the PMTU in different fields, it is observed that many studies do not consider students' learning styles in the planning of such units. According to Alonso (1992) and Portilho (2011), learning styles can be classified as active, reflective, theoretical, or pragmatic, and their identification is possible through the CHAEA[1] questionnaire (*Cuestionario Honey-Alonso de Estilos de Aprendizaje*), a validated instrument for educational contexts. In view of this gap, the guiding research question of this study emerges: how can the identification of learning styles contribute to the planning

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[1] Acronym for *Cuestionario Honey-Alonso de Estilos de Aprendizaje*

and implementation of a PMTU that strengthens meaningful learning in Upper Secondary Technical Education?

Based on this question, this article aims to discuss the importance of understanding students' learning styles to promote more effective education in Upper Secondary Technical Education. To this end, it proposes an explanatory literature review on learning styles, aiming at the subsequent application of a questionnaire and the construction of a PMTU that considers these styles among students of vocational courses, in order to strengthen meaningful learning.

Through this approach, the study also seeks to contribute to the improvement of teaching practices in the context of technical education. This article is part of the introductory research phase of a Scientific Initiation Project (IC), linked to the "Education" Research Group of a Higher Education Institution (HEI), in which the student proposes to develop a PMTU that considers the learning styles of vocational students, with the aim of strengthening meaningful learning in Upper Secondary Technical Education.

In this sense, the research is characterized as bibliographical and explanatory, with a qualitative approach, grounded in theoretical frameworks on meaningful learning and learning styles, encompassing the contributions of Ausubel (1968, 2000), Novak (1984), Moreira (2009, 2011), Alonso (1992), Kolb (1984), and Portilho (2011). Initially, a systematized literature review is conducted, seeking to identify how learning styles have been addressed in studies applied to Upper Secondary Technical Education. Subsequently, the selection and analysis of instruments for identifying learning styles will be carried out, with emphasis on the CHAEA questionnaire. Based on these analyses, the study aims to develop a PMTU proposal that considers different learning styles, allowing instructional strategies to be adapted to students' characteristics.

It is expected that the development of the PMTU will provide more inclusive and effective pedagogical practices, strengthen meaningful learning, increase student engagement and motivation, and offer support for future research and pedagogical practices in vocational technical courses. Finally, this study contributes to the discussion of differentiated pedagogical practices, reinforcing the importance of educational strategies

that consider students' singularities and offering a methodological proposal that may serve as a reference for vocational technical courses.

2 Methodology

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Through a bibliographical review of a basic and explanatory nature, this study sought to conduct a theoretical survey of the main learning theories that underpin the educational process. In this context, the proposal of Ausubel (2003) is highlighted, emphasizing the importance of meaningful learning and the relationship between new knowledge and students' prior knowledge. Complementarily, the concept of Critical Meaningful Learning, developed by Moreira (2010), is considered, which broadens the "Ausubelian" perspective by incorporating reflections on learners' autonomy and criticality in the process of knowledge construction.

In addition, the study addresses pedagogical differentiation through the personalization of the teaching–learning process, based on learning styles models proposed by Honey and Alonso (1982), Kolb (1984), and Fleming (1987). These frameworks contribute to understanding how different student profiles assimilate and process information, providing support for more adapted and effective teaching practices.

This article is part of the introductory research phase of a Scientific Initiation Project (IC), linked to the "Education" Research Group of a Higher Education Institution (HEI), in which the student proposes to develop a PMTU that considers the learning styles of students enrolled in vocational courses, with the aim of strengthening meaningful learning in Upper Secondary Technical Education.

3 Meaningful learning according to David Ausubel

The theory of meaningful learning, developed by Ausubel (2003), is one of the pillars of cognitive education, as it emphasizes the importance of prior knowledge in the construction of new knowledge. The author states that "the most important single factor
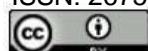
influencing learning is what the learner already knows" (Ausubel, 2003, p. 23). In this context, Saron (2016) highlights the need to understand how students construct their knowledge and how teaching methodologies can facilitate this process, aiming at more effective and lasting learning.

Figure 1 shows the difference between meaningful learning and rote learning. Meaningful learning occurs when new knowledge is related in a non-arbitrary and substantive way to what the student already knows, promoting deeper understanding. Rote learning, on the other hand, is characterized by the memorization of information without connection to prior knowledge, such as the memorization of formulas without proper understanding of their meaning.

Figure 1 – Meaningful Learning vs. Rote Learning
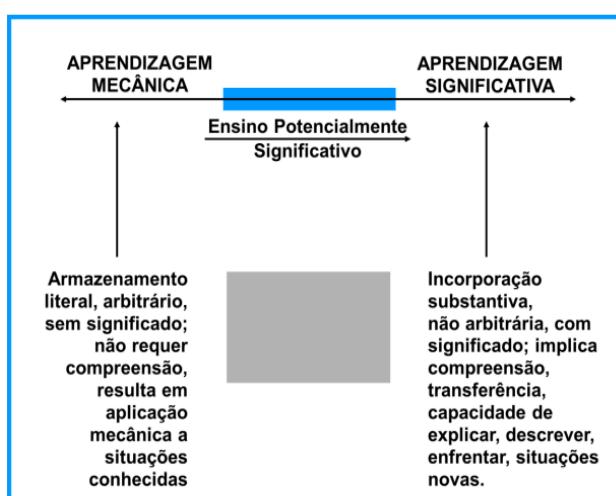
Source: Moreira (2015)

Ausubel (2003) emphasizes that learning becomes meaningful when new knowledge is related in a non-arbitrary way to concepts already consolidated in the learner's cognitive structure. This process is enhanced through the use of advance organizers, which act as cognitive bridges capable of facilitating the incorporation and retention of new content.

For this process to occur effectively, it is essential that students demonstrate a predisposition to learn and that teachers recognize and value students' prior knowledge, developing materials and instructional strategies that stimulate the integration between old and new knowledge.

From this perspective, the author establishes three fundamental conditions for the occurrence of meaningful learning:

1. Students' willingness to learn.
2. Prior knowledge.
3. Intentional teacher intervention as a mediator of the teaching–learning process.

The following section presents a description of these three aspects.

3.1 Students' willingness to learn

Students' willingness constitutes an essential element for the achievement of meaningful learning, as it involves not only attention and interest, but also the intentionality to learn. When students perceive meaning in what they study, they become active subjects in the process of knowledge construction. In this sense, Novak (1998) understands meaningful learning as a holistic process that integrates cognitive, affective, and psychomotor dimensions, being deeply influenced by the context in which it occurs. This perspective indicates that emotional engagement and personal connection with the content are as important as intellectual aspects, as they favor the internalization of knowledge and its application in new situations.

Motivation, therefore, emerges as a determining factor for students to establish relationships between new knowledge and the knowledge they already possess. Gomes (2024) emphasizes that learning is the driving force of the learning process itself and that curiosity stimulates the continuous desire to know more. This movement of search and expansion of knowledge creates a virtuous cycle, in which learning ceases to be a punctual activity and becomes a permanent process of meaning-making. This idea is aligned with the theory of multiple intelligences proposed by Gardner, according to which learning is

linked to the ability to make inferences, recognize patterns, and apply concepts in different contexts, which reflects a deeper and more lasting learning.

Complementarily, Ausubel (2003) and Moreira (2011) reinforce that students' motivation depends on the possibility of establishing links between new content and relevant prior knowledge organized in their cognitive structure. When teachers provide conditions for this integration through practical examples, contextualized activities, and meaningful mediation, students recognize the usefulness of what they learn and broaden their willingness to participate actively in teaching situations. Thus, willingness is not a fixed state, but a dynamic process cultivated through the interaction among the learner, the content, and the learning environment. This view highlights the role of the educator as a mediator of meanings, capable of awakening and sustaining students' engagement toward truly meaningful learning.

3.2 Prior knowledge

Meaningful learning occurs when students possess prior concepts or ideas that serve as a basis for the assimilation of new content. As previously stated, this prior knowledge functions as cognitive structures that facilitate the understanding and incorporation of new information. When new content connects in a logical and coherent way with what students already know, there is greater potential for learning to be lasting and relevant. Therefore, it is essential that educators take students' prior knowledge into account when planning their pedagogical practices (Ausubel, 2003).

In this sense, it becomes essential for educators to consider students' previous knowledge when planning their teaching practices. Moreira (2011) emphasizes that meaningful learning requires constant interaction between new content and ideas previously structured in the learner's mind, allowing knowledge to be assimilated in a consistent and integrated way.

3.3 Teacher's role

The teacher plays a central role as a mediator in the teaching–learning process, being responsible for planning, selecting, and applying instructional strategies and resources that favor the active construction of knowledge by students. This mediation goes beyond the simple transmission of information; it presupposes pedagogical intentionality, attentive listening, and sensitivity to recognize and value students' prior knowledge, promoting meaningful and contextualized learning.

According to Ausubel (2003), meaningful learning occurs when new information connects, in a substantive and non-arbitrary way, with the knowledge already existing in the student's repertoire. In other words, it is essential that the content makes sense to the learner and that the teacher acts as a facilitator of this connection. For this purpose, it is necessary to know students' sociocultural reality, their experiences, interests, and challenges, in order to propose learning situations that arouse engagement and relevance.

In this context, the perspective of critical meaningful learning, developed by Moreira (2011), broadens this understanding by emphasizing that the teacher's role is not limited to the facilitation of knowledge, but implies an ethical commitment to the formation of critical subjects, capable of reflecting on their reality and transforming it. Teaching practice, therefore, should be guided by a reflective and dialogical approach, which stimulates critical thinking, the debate of ideas, and the construction of intellectual autonomy. Promoting a learning environment that values questioning, problematization, and cooperation is essential for citizenship education.

Therefore, it is necessary to recognize that the complexity of the teaching role requires constant updating, study, and reflection on one's own practice. Teachers must be open to revising methods, incorporating new technologies, and listening to their students, remaining committed to an education that promotes the full and emancipatory development of learners.

4 Critical Meaningful Learning and the Potentially Meaningful Teaching Unit (PMTU)

Moreira (2010) expands Ausubel's theory by introducing the concept of Critical Meaningful Learning, which goes beyond the simple integration of new knowledge into the student's cognitive structure, also proposing reflection, questioning, and the transformation of paradigms. This critical approach advocates an education embedded in the cultural context, but with the potential to promote and transform it.

Continuing this perspective, Moreira (2011) developed the Potentially Meaningful Teaching Unit (PMTU/UEPS), a proposal for a didactic sequence based on the Theory of Meaningful Learning. Its objective is to break with rote learning, promoting an active and contextualized construction of knowledge, applicable to different levels of education. The PMTU is grounded on pillars such as the valorization of prior knowledge (Ausubel), the articulation between thought, feeling, and action (Novak), continuous assessment, and meaningful interaction among student, teacher, and teaching materials (Moreira, 2010).

Inspired by this proposal, Saron (2016) also developed a PMTU/UEPS in his doctoral thesis. However, before preparing the material, he investigated students' learning styles through the CHAEA questionnaire (*Cuestionario Honey-Alonso de Estilos de Aprendizaje*). Based on the results, he guided the construction of the didactic sequence using techniques aligned with the predominant learning style of the class. As a result, greater student interest in the content was observed, as well as better comprehension, greater applicability of knowledge, and more lasting retention of learning.

Novak (1984), drawing on Ausubel's theory and through a constructivist approach, sought to apply concept mapping with the aim of supporting the expansion of knowledge, refining it, and applying it scientifically. He also emphasized that the shift from rote learning habits to conceptual teaching is related to the teacher's presentation of conceptual instructions. Bryce *et al.* (2024), analyzing the theory of meaningful learning proposed by David Ausubel, revisit its application in education in light of discoveries and advances from Neuroscience.

4.1 Forms of meaningful learning

Meaningful learning, also referred to as learning by assimilation, can manifest itself in three forms: subordinate, superordinate, and combinatorial (Pivato; Schuhmacher, 2013), as explained below.

Subordinate learning occurs when new information connects to concepts already existing in the student's cognitive structure. The process begins with more general ideas, which become progressively more detailed and specialized, characterizing progressive differentiation (Pivato; Schuhmacher, 2013). According to Ausubel, Novak, and Hanesian (1980, p. 50), "subordinate learning occurs when new ideas are anchored to existing concepts, becoming progressively more specific and differentiated."

Superordinate learning, in turn, can be explained when the newly presented information is more comprehensive and general than the concepts previously acquired by the learner. This means that the student learns a new principle or proposition that will serve as a basis for future cognitive connections. As stated by Ausubel, Novak, and Hanesian (1980), superordination occurs when the assimilated information becomes more inclusive than prior knowledge, providing an inductive organization of content.

Combinatorial learning occurs when new information is neither subordinated nor superordinated to existing knowledge, but is still connected to prior knowledge. According to Vieira (2012), this type of learning involves broad propositions that do not have a clear hierarchical relationship with previous concepts. Pozo and Crespo (2009) highlight that, unlike subordinate and superordinate learning, combinatorial learning is not directly anchored to a specific idea already present in the student's cognitive structure.

Lara and Souza (2009) emphasize that the occurrence of these types of learning is directly related to the processes of progressive differentiation and integrative reconciliation, with the former being more associated with subordination and the latter with superordination.

## 4.2 Organizational and programming principles

In the model of meaningful learning, progressive differentiation and integrative reconciliation are fundamental principles. Progressive differentiation refers to the hierarchical structuring of content, starting from broader and more general concepts and moving toward more specific ones. Integrative reconciliation, in turn, emphasizes the need to establish connections among concepts at different levels, promoting a broader and more interconnected understanding of knowledge. According to Parisoto (2015), this process allows concepts to evolve gradually, acquiring new meanings within the learner's cognitive structure.

Progressive differentiation, as explained by Parisoto (2015), occurs when concepts undergo a continuous process of refinement and evolution, acquiring new meanings as they connect with other elements in the learner's cognitive structure. This conceptual development enables a more detailed and structured understanding of content.

Integrative reconciliation plays an essential role in the organization of knowledge, as it allows students to establish conceptual hierarchies and understand the relationship between different concepts. Vieira (2012) highlights that this process contributes to clarity of meanings and better cognitive organization of learners. Valério (1999) adds that integrative reconciliation can occur in both superordinate and combinatorial learning, providing a broader and more interconnected view of the assimilated content.

Figure 2 presents the "Ausubelian" model of progressive differentiation and integrative reconciliation, which represents a dynamic process in which concepts evolve from the most general to the most specific and later return to a broader level, promoting the consolidation of learning. This movement is illustrated by dark and light lines that indicate the need for deepening and revisiting concepts. In addition, the connections among knowledge do not occur only vertically, but also crosswise and horizontally, evidencing the interconnected nature of the learning process.

Figure 2 – Progressive differentiation and integrative reconciliation
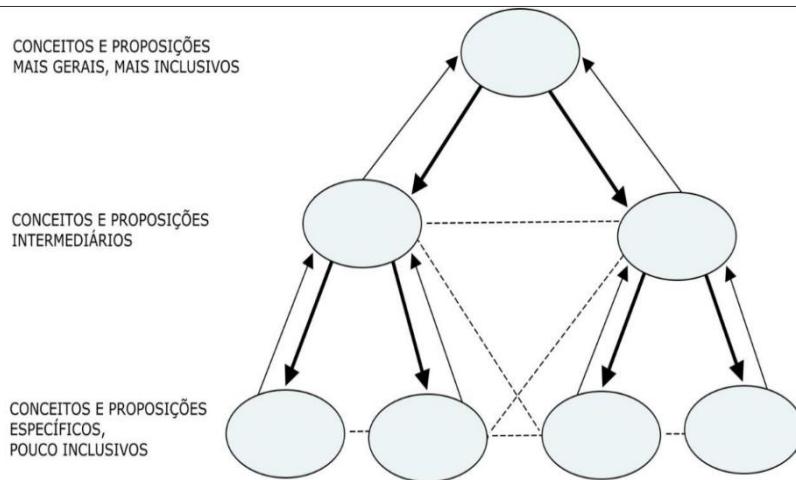
Source: Moreira (2015)

Bryce *et al.* (2024, p. 4590) state that the success of classroom strategies "depends on the teacher's ingenuity in designing advance organizers and mental sets that can promote students' understanding."

5 Pedagogical Differentiation – Personalization of the Teaching–Learning Process

Pedagogical differentiation is a teaching approach that recognizes and values differences among students — their pacing, learning styles, interests, prior knowledge, and needs. Instead of applying the same strategy to all learners, teachers adapt content, processes, products, and the learning environment to better address classroom diversity. The following methods will be presented: the Honey–Alonso Method, the Kolb Learning Method, and the VARK Learning Method.

The Honey–Alonso Learning Method was developed by the psychologist Peter Honey and the doctor of education Catalina Alonso, and it proposes a learning cycle that results from the interaction between the environment, adult learners' previous experiences,

and individually constructed knowledge. The cycle comprises four learning styles, namely: active, reflective, pragmatic, and theoretical.

Below, the Honey–Alonso learning method applied to mathematics teaching–learning, specifically the content of Fractions, is presented for each learning style:

- **Active style:** use the "Build a Fraction" simulator to explore fractions in an interactive and playful way, facing challenges and experimenting with different combinations.
- **Reflective style:** observe the results obtained and reflect on different ways of combining fractions, analyzing the impact of each choice.
- **Pragmatic style:** apply the fractions created in the simulator to real-world problems, such as sharing a pizza among friends or measuring ingredients for a recipe.
- **Theoretical style:** study the mathematical principles behind fractions, using the simulator to test and confirm theories about fraction equivalence and simplification.

The Kolb Learning Method was developed by the American educational theorist David Kolb in 1976 and proposes an experiential learning cycle based on an individual's attitudes and emotions during learning. This cycle involves four main abilities: (i) Concrete experience; (ii) Reflective observation; (iii) Abstract conceptualization; and (iv) Active experimentation.

Saron (2016) proposes an articulation between Ausubel's Theory of Meaningful Learning and Kolb's learning styles, based on the prior recognition of students' learning profiles. The author argues that, by identifying the dominant learning style of a group, teachers can select more appropriate instructional techniques, promoting an environment favorable to meaningful learning. In his research, Saron found that the pragmatic style was the most evident among the participants, and, through the application of practical activities aligned with this profile, observed greater interest, understanding, and retention of the taught content.

The VARK method, developed by Neil Fleming, is a tool that helps to identify an individual's preferred learning style. The name VARK is an acronym that represents four sensory learning modalities: Visual, Auditory, Read/Write, and Kinesthetic (Fleming, 1987).

According to Fleming (1987), the four sensory learning modalities of the VARK model are:

V – Visual (images, graphs, diagrams, maps)

A – Auditory (audio, conversations, music, lectures)

R – Read/Write (texts, lists, notes, articles)

K – Kinesthetic (movement, practice, experiences, concrete examples)

Bryce *et al.* (2024), in their analysis and contextualization of the teaching–learning process of children and adolescents in the 21st century, highlight that for each subject and content in formal education there are numerous websites, videos, and tips (including for teachers) on how to question students, either in groups or individually. The convergent point is always the challenge of discovering what students "know"; however, the recommendation is to discover what students "think and associate" with the taught content.

At this point, the same authors emphasize the importance of studying and researching human memory and its dynamic nature, especially in the process of information re-entry, which generates immediate associations, such as words and images in the form of recall, with memory being understood as a constructive recategorization.

> Therefore, with regard to the act of remembering, an individual is actively formulating images and explanations in an intersected manner during recall processes, drawing on available thoughts. […] Performance should be interpreted as a dance, a theatrical act, or a musical execution. There are no two identical performances, even when the same routine, script, or score is used: the creative process results in slightly different outcomes. […] Remembering is the reconstruction of neural pathways to produce what appears to be a memory, but it does not resemble a file, a recording, or a material object (Bryce *et al.*, 2024, p. 4586-4587)

Thus, Bryce and Blown (2024) argue that Ausubel's theory needs to be articulated in a multimodal way, that is, by using all or several sensory modalities, in addition to re-signifying concepts as skills or competences, recognizing the dynamic nature of cognition.

The theory of meaningful learning proposed by Ausubel has been reinterpreted by contemporary authors, such as Bryce and Blown (2024), who defend its multimodal articulation. This perspective proposes the integrated use of different sensory modalities in the educational process, recognizing the dynamic nature of cognition and the importance of redefining concepts as skills and competences. Learning, in this sense, is not merely the assimilation of content, but the active construction of knowledge that involves multiple ways of perceiving, feeling, and interacting with the world.

This understanding is aligned with the concept of Critical Meaningful Learning (Moreira, 2010), which expands the original proposal by incorporating critical and reflective dimensions. Learning comes to be seen as a transformative process that considers students' sociocultural contexts, their prior knowledge, and their particular ways of learning. In this scenario, the importance of pedagogical differentiation and the personalization of teaching is highlighted, based on models that identify learning styles, such as those proposed by Honey and Alonso (1982), Kolb (1984), and Fleming (1987).

When applied in an integrated way to teaching practice, these three models contribute significantly to the personalization of teaching. They provide instruments to diagnose students' preferred learning styles and to adapt pedagogical strategies in order to foster engagement, understanding, and knowledge retention. When combined with the principles of meaningful learning, such as the valorization of prior knowledge, the logical organization of content, and the connection with students' reality, these models enrich the learning experience and favor the construction of deep meanings.

In summary, integrating multimodality, criticality, and personalization in the teaching–learning process represents an advance in the understanding of meaningful learning. This approach requires from educators not only theoretical knowledge, but also pedagogical sensitivity to create experiences that dialogue with diversity and develop competences relevant to students' personal, academic, and professional lives. In this context, the Honey–Alonso, Kolb, and VARK models are fundamental allies for a more responsive, inclusive, and transformative education.

4 Final considerations

The theory of meaningful learning focuses on the connection of new knowledge with existing cognitive structures, requiring prior knowledge, student motivation, and relevant materials. Its application can enhance understanding, retention, and practical skills across all disciplines, although the evolution of research and practical challenges highlight the need for continuous adaptation and integration in educational practice.

Thus, teachers' choice of active methodologies for the teaching–learning process is important precisely because of their effectiveness in connecting new information to the existing knowledge structures in students' minds, in contrast to rote memorization, and with a particular focus on understanding, integration, and the practical application of knowledge.

Recent advances in cognition and neuroscience challenge certain aspects of Ausubel's original theory, such as the nature of memory and conceptual change. Nevertheless, there is a growing recognition of the dynamic and non-representational nature of memory and of the importance of collaborative learning and scaffolding in modern educational environments. Despite these benefits, the theory of meaningful learning is not always fully implemented in practice, making it necessary to better connect theoretical frameworks with classroom activities.

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How to cite this article (ABNT):

FURTADO, Maykon Nise; GOMES, Karin Pfannemüller; SARON, Alexandre; Konrad, Adilson. Estilos de Aprendizagem e UEPS: possibilidades para aprendizagem significativa no ensino técnico de nível médio. **Rev. Pemo**, Fortaleza, v. 8, e15777, 2026. Available at: https://revistas.uece.br/index.php/revpemo/article/view/15777