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MEANINGFUL LEARNING AND CONCEPT MAPS: FUNDAMENTALS, INTERFACES, AND IMPLICATIONS FOR TEACHING MATHEMATICS

Vanussa Gislaine Dobler de Souza

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Contemporary education faces the ongoing challenge of overcoming models centered on memorization and moving toward pedagogical practices that promote deep understanding, intellectual autonomy, and the ability to transfer knowledge. In this scenario, the Theory of Meaningful Learning (TML), proposed by David Ausubel, emerges as one of the most influential contributions of Cognitive Psychology applied to education, emphasizing that learning is essentially attributing meaning to new knowledge based on what the learner already knows.

This perspective gains even more relevance in light of the social, cultural, and technological transformations that characterize the 21st century. In a world marked by the rapid circulation of information, it is not enough to accumulate data: it is essential to develop the ability to understand, relate, interpret, and apply knowledge in different contexts. Schools, therefore, are called upon to review their practices, shifting the focus from the simple transmission of content to the construction of learning experiences that make sense to students and contribute to their comprehensive education.

In this context, meaningful learning presents itself as a theoretical and methodological alternative capable of guiding concrete changes in pedagogical practice. By recognizing the importance of prior knowledge, motivation, and the hierarchical organization of concepts, this approach redefines the role of the teacher, who is no longer just a transmitter of information but acts as a mediator, organizer, and facilitator of the knowledge-building process.

The teaching of mathematics, in particular, is a fertile field for the application of these principles. Traditionally associated with abstraction and difficulty, this subject has often been taught mechanically, based on the repetition of procedures and the memorization of formulas. This approach contributes to the construction of a negative image of mathematics and to the difficulty many students have in understanding its usefulness and relevance. Meaningful learning proposes a different path, in which mathematical concepts are presented progressively, connected to everyday life and articulated with real experiences. In this movement of transformation, Concept Maps emerge as a powerful pedagogical tool, capable of making the relationships between concepts visible and favoring the organization of knowledge.

This article discusses the fundamentals of meaningful learning, its connection to mathematics teaching, and the role of Concept Maps as a pedagogical tool capable of materializing, visualizing, and evaluating this process. Throughout the discussion, it is argued that the integration of cognitive theory, teaching strategies, and knowledge representation tools constitutes a promising path for the transformation of educational practices, favoring the construction of deeper, more critical, and lasting learning.

Fundamentals of Meaningful Learning Theory

The Theory of Meaningful Learning (TML), proposed by David Ausubel in the field of Cognitive Psychology, represents a profound change in the understanding of the educational process by arguing that learning does not only mean memorizing information, but attributing meaning to new knowledge based on what the student alre-

ady knows. This perspective shifts the focus of education from the transmission of content to the organization of knowledge and the construction of meaning, highlighting the need to understand how learners think, interpret, and integrate new information into their cognitive structure.

Cognitive psychology, the theoretical basis of TAS, is dedicated to the study of the mental processes involved in learning, memory, and the use of information. In this sense, Moreira and Masini (1982, p. 3) state that "cognition is the process through which the world of meanings originates," highlighting that human beings learn by attributing meanings to the reality that surrounds them. Thus, each student arrives in the classroom with their own cognitive history, composed of previously constructed experiences, concepts, beliefs, and interpretations. Learning, therefore, does not begin when the teacher presents content, but when that content finds points of connection with what already exists in the learner's mind.

This principle gains strength in the classic formulation by Ausubel, Novak, and Hanesian (1980, p. 137), who state that "the single most important factor influencing learning is what the learner already knows. Determine this and teach accordingly." This statement redefines pedagogical planning, as it makes it essential to investigate students' prior knowledge before introducing new content. Teaching ceases to be a linear sequence of information and becomes a process of mediation, organization, and integration of meanings.

At the heart of the theory is the concept of subsumption, understood as the knowledge already existing in the cognitive structure that serves as the basis for the assimilation of new information. When a new concept finds relevant subsumptions, it acquires meaning; at the same time, these subsumptions are transformed and become more elaborate. Moreira (2008, p. 1) explains that this process does not occur unilaterally, because "more relevant and inclusive concepts interact with the new information, functioning as an anchor, assimilating the new material and, at the same time, modifying themselves as a result of this anchoring." Thus, meaningful learning involves a dynamic interaction between the new and the already known, promoting constant reorganization of the cognitive structure.

This interaction distinguishes meaningful learning from rote learning. In meaningful learning, knowledge is integrated in a non-arbitrary and non-literal way, allowing students to understand and explain the content in their own words. In rote learning, on the other hand, information is memorized without connection to prior knowledge, which favors rapid forgetting and limits the application of content to situations very similar to those studied. Postman and Weingartner (1969, p. 62) reinforce this idea by stating that "we can, after all, only learn in relation to what we already know," showing that learning depends directly on the previously constructed cognitive base.

The process of knowledge assimilation involves two fundamental movements: progressive differentiation and integrative reconciliation. Progressive differentiation refers to the gradual enrichment of more general concepts, which incorporate new information and become more specific. Moreira (2012, p. 6) defines this process as "the attribution of new meanings to a given subsumption." Integrative reconciliation occurs when students establish relationships between concepts, eliminate apparent contradic-

tions, and integrate meanings into a more coherent cognitive structure. Regarding this process, Moreira (2012, p. 6) states that it consists of "eliminating apparent differences, resolving inconsistencies, integrating meanings, and making superordinations." Both movements occur simultaneously and are responsible for the hierarchical organization of knowledge.

For meaningful learning to occur, Ausubel (2003) highlights three essential conditions: the existence of relevant prior knowledge, the student's predisposition to learn, and the organization of learning material according to the student's cognitive level. Motivation plays a decisive role. Novak and Cañas (2010, p. 11) note that "the teacher has no direct control over students' motivation to learn by trying to incorporate new meanings into their prior knowledge," but can influence it through teaching strategies that favor the connection between the new and the already known.

In this context, advance organizers emerge as one of the main practical contributions of the theory. Moreira and Masini (1982, p. 103) define advance organizers as "introductory material presented before the material to be learned, at a higher level of generality, inclusiveness, and abstraction, intended to serve as a bridge between what the learner already knows and what they need to know." These organizers function as cognitive bridges that facilitate the assimilation of content, providing an overview before the details are presented.

Language also plays an essential role in this process. Meaningful learning involves dialogue and the exchange of meanings, requiring students to be able to explain concepts in their own words and relate them to the context of the subject. This reinforces the need for a collaborative learning environment, in which the teacher acts as a mediator and facilitator of knowledge.

Given this scenario, Meaningful Learning Theory proposes a transformation in the role of schools and teachers. Educators are no longer mere transmitters of information, but rather mediators, organizers, and facilitators of the knowledge-building process. The classroom becomes a space for dialogue, investigation, and integration of meanings, promoting the development of intellectual autonomy and the ability to learn continuously.

In short, meaningful learning offers a solid basis for rethinking contemporary teaching. By valuing prior knowledge, motivation, conceptual organization, and the progressive integration of knowledge, this theory contributes to the construction of a deeper, more critical, and more lasting education.

Understanding meaningful learning also requires reflecting on the role of time, continuity, and review in the educational process. The construction of meaning does not occur instantaneously or linearly; it develops through successive interactions between new knowledge and existing cognitive structures. In this process, revisiting content, revisiting concepts in different contexts, and providing multiple opportunities for application become essential strategies for consolidating learning. Ausubel (2003) observes that knowledge retention is directly related to how it was assimilated, noting that "retention reflects a resistance to the increasing incursions of obliterating assimilation" (AUSUBEL, 2003, p. 129). This means that the more meaningful the learning, the longer it will remain in long-term memory.

Review, therefore, should not be understood as a simple repetition of exercises, but as an opportunity for cognitive reorganization. By revisiting content from different perspectives, students broaden their understanding, strengthen conceptual relationships, and deepen meanings. This process is particularly important when considering that meaningful learning does not completely eliminate forgetting, but transforms it into a partial and less harmful phenomenon. Even when details are lost, conceptual traces remain embedded in subsumers, facilitating the reconstruction of knowledge when necessary.

Another fundamental aspect refers to the importance of social and cultural context in learning. Students do not arrive at school with only conceptual knowledge, but also with life experiences, values, languages, and their own ways of interpreting the world. These dimensions influence the way school content is understood and integrated. For this reason, meaningful learning presupposes that teaching takes into account the diversity present in the classroom, recognizing that different trajectories produce different cognitive structures. Working with everyday examples, contextualized problem situations, and collaborative activities contributes to making the content closer to the students' reality and, consequently, more meaningful.

In this scenario, assessment takes on a formative and continuous role. Instead of being restricted to verifying results, it begins to accompany the learning process, offering information about how the student is constructing meaning. Diagnostic assessment allows for the identification of prior knowledge and guides planning; formative assessment provides feedback along the way;

and summative assessment summarizes the results achieved. This set of practices contributes to making teaching more responsive to students' needs and more aligned with the principles of meaningful learning.

Motivation remains a cross-cutting element in this process. The perception of content relevance, the feeling of competence, and the possibility of active participation favor student engagement. Novak and Cañas (2010, p. 11) point out that "teaching strategies that emphasize the relationship between new knowledge and the learner's existing knowledge favor Meaningful Learning." Thus, when students perceive that the content relates to their reality and interests, they are more willing to invest cognitive effort and establish connections.

Curriculum organization also needs to be rethought in light of these principles. A curriculum structured solely as a sequence of disconnected topics hinders the construction of relationships between concepts and favors the fragmentation of knowledge. In contrast, an organization that privileges central ideas, structuring concepts, and hierarchical relationships favors integration and understanding. Masini and Moreira (2006, p. 30) emphasize that content programming should "explore relationships between propositions and concepts, draw attention to important differences and similarities, and reconcile real or apparent inconsistencies," reinforcing the importance of integrative reconciliation as a pedagogical principle.

In addition, meaningful learning has direct implications for the development of intellectual autonomy. When students learn to relate concepts, explain ideas in their own words, and apply knowledge in new situations, they develop skills that go beyond the specific content of a subject. They learn

to learn, to investigate, to question, and to build knowledge continuously. This ability is particularly relevant in a society marked by the rapid production of information and the need for constant updating.

The role of the teacher, in this context, is profoundly transformed. The educator ceases to be the sole source of knowledge and takes on the role of mediator, guide, and organizer of learning experiences. Their work involves diagnosing prior knowledge, selecting structural concepts, planning coherent teaching sequences, and creating environments that favor dialogue and the collective construction of meaning. This change requires continuous training, reflection on practice, and openness to methodologies that value active student participation.

Meaningful learning also reinforces the importance of collaboration. Group activities, debates, and collective projects allow students to confront ideas, share experiences, and construct meaning together. This process favors the development of social and cognitive skills, broadening understanding of content and promoting respect for diversity of perspectives.

Finally, Meaningful Learning Theory points to an education guided by understanding, integration, and autonomy. By valuing prior knowledge, motivation, conceptual organization, and pedagogical mediation, this approach offers a solid foundation for building more effective and humanizing educational practices. In a social context marked by complexity and constant transformation, training individuals capable of understanding, relating, and applying knowledge becomes an essential task. Meaningful learning, in this sense, is not just an educational theory, but an invitation to transform school culture itself.

Meaningful Learning in Mathematics Education

Meaningful learning applied to mathematics education is based on the relationship between new knowledge and students' prior knowledge, in a non-arbitrary and personally meaningful way. As Jesus states:

> Meaningful learning (whether through discovery or reception) depends on important conditions such as: that the student is willing to engage in meaningful learning, that the material is potentially meaningful, and, above all, that it is possible to incorporate it into the cognitive structure (...) in a non-arbitrary and substantive manner" (JESUS, 1999, p. 25).

When these conditions are met, the student transforms the logical meaning of the content into psychological meaning, unlike mechanical learning, which is based on memorization. In this sense, Ziccardi and Fusco emphasize that "for meaningful learning of a given content to occur, there must be emotional involvement in order to integrate new knowledge with existing knowledge in a well-organized and relevant knowledge structure" (ZICCARDI; FUSCO, 2019, p. 115).

In mathematics teaching, this perspective requires the progressive organization of content, starting with fundamental concepts and gradually advancing to more complex ones. Ausubel states that meaningful reception learning requires materials that

respect "the principles of progressive differentiation and integrative reconciliation in instructional materials" (AUSUBEL, 2000, p. 6). The contextualization of teaching is also essential: problem- solution, collaborative work, and the use of technologies make learning more relevant and stimulate critical thinking. However, many school practices still favor traditional methods. Moreira criticizes that elementary schools continue to promote rote learning, in which students "memorize on the eve of tests, reproduce memorized knowledge without meaning (...) and quickly forget it" (MOREIRA, 2011, p. 19). D'Ambrósio warns that the pedagogical routine "leads to a lack of creativity and, consequently, to inefficiency" (D'AMBRÓSIO, 2000, p. 104-105), highlighting the need to transform teaching practices.

The National Common Core Curriculum reinforces the importance of building on students' experiences and articulating different areas of knowledge. In this context, formative assessment plays a central role. Ausubel points out that cognitive structure can be influenced "through appropriate methods of presentation, arrangement, and assessment of meaningful acquisition of the material" (AUSUBEL, 2000, p. 26). In addition, Freire criticizes banking education by stating that students are seen as "containers to be 'filled' by the educator" (FREIRE, 1986, p. 33), advocating for education based on the active construction of knowledge. Thus, promoting curiosity, self-assessment, and questioning strengthens autonomy and metacognition, preparing students to apply mathematical knowledge in different contexts.

Another fundamental aspect of meaningful learning in mathematics education refers to the integration between different areas of knowledge and the appreciation of real-life situations as a starting point for the development of pedagogical activities. When students are challenged to apply mathematical concepts in everyday contexts, such as financial planning, data analysis, or practical problem solving, they begin to realize the social utility of the discipline. This connection with reality promotes motivation and broadens the meaning of what is learned, helping mathematics to be seen not as a set of abstract procedures but as a tool for interpreting and transforming the world.

In addition, the use of digital technologies and active methodologies can significantly enrich the teaching and learning process, enabling immediate feedback, personalization of teaching, and greater interaction among students. Virtual environments, simulators, and educational software expand the possibilities for experimentation and visualization of concepts, promoting the construction of knowledge in a collaborative and dynamic way. Thus, the combination of formative assessment, interdisciplinary practices, and technological resources strengthens meaningful learning and contributes to the formation of critical, autonomous individuals who are prepared for the challenges of contemporary society.

Concept maps and mathematics

Concept maps (CMs) emerged from Joseph Novak's research in the 1970s, strongly influenced by David Ausubel's theory of meaningful learning. Since its inception, the central purpose of this tool has been to graphically represent knowledge and make the relationships between concepts visible.

According to the material, the creation of CMs sought to "provide a clearer and more structured view of knowledge, allowing educators to visualize the relationships between concepts in a hierarchical and interconnected way."

The classic definition of concept maps highlights their nature as cognitive tools for organizing knowledge. According to Novak and Cañas (2010, p. 10), "concept maps are graphic tools for organizing and representing knowledge," composed of concepts connected by lines and linking words that specify the relationships between them. This structure allows for the graphical representation of how knowledge is organized in the learner's mind.

The theoretical basis of CMs is directly linked to meaningful learning. This approach maintains that knowledge needs to be integrated with the student's prior knowledge, not just memorized. Thus, the material must be organized, and the learner must have prior knowledge that allows them to attribute meaning to the new content.

Concept maps make this process visible because they organize concepts hierarchically. Novak and Cañas state that the most general concepts should be at the top, while the more specific ones are distributed at the lower levels, and ideally the map should be constructed from a focal question. In this way, the concept map is not just a visual outline, but a representation of the meaningful relationships between ideas.

It is important to note that CMs should not be confused with other diagrams. Moreira (1997) states that "concept maps are diagrams of meanings, of meaningful relationships, of conceptual hierarchies" and should not be confused with organizational charts, mind maps, or synoptic tables. This distinction reinforces their specificity as a meaningful learning tool.

Structurally, concept maps are composed of concepts, propositions, and linking words. According to Peña (2005), "the proposition articulates two or more concepts through linking words," allowing knowledge to be transmitted in a more accessible way. The presence of cross-links indicates integrative reconciliation, signaling that learning has been deepened.

Concept maps as an assessment tool

Another essential feature is the dynamic nature of concept maps. Coelho and Marques (2020) state that "the concept map is not something static. It changes over time as the learner observes new relationships between meanings." This shows that CMs reflect the evolution of knowledge and the constructive nature of learning.

Assessing the effectiveness of pedagogical tools is one of the greatest challenges in the teaching and learning process, as it involves multiple dimensions related to students' cognitive, emotional, and social development. In this context, concept maps (CMs) stand out as a relevant tool for both organizing knowledge and assessing meaningful learning.

One of the most common ways to evaluate the effectiveness of concept maps is to analyze students' academic performance before and after applying the tool. Improvements in tests and exams may indicate advances in understanding and retention of content, although it is necessary to consider that several factors can influence these results. In addition, the concept map itself can

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be used as an assessment tool, allowing for the examination of depth of understanding, complexity of connections, and the ability to apply knowledge in new contexts. However, learning assessment should not be limited to quantitative indicators. Qualitative assessments, such as interviews, group discussions, and classroom observations, provide essential information about students' and teachers' perceptions of the use of concept maps, their benefits, and challenges. These strategies make it possible to understand the level of student engagement, their difficulties, and the possibilities for improving teaching practices.

The use of CMs as an assessment tool requires planning and clarity in the analysis criteria. In addition, students need to master, at least at a basic level, the technique of conceptual mapping. Mousinho emphasizes that "there is no relevance in considering or classifying a concept map as right or wrong, since, being a representation of knowledge, it is in a permanent process of construction" (MOUSINHO, 2019, p. 36). This perspective reinforces the formative and procedural nature of assessment through maps. Several studies indicate that the use of CMs contributes to clarity and depth of understanding, in addition to increasing student motivation. Visualizing the relationships between concepts promotes meaningful learning and the transfer of knowledge to new situations.

In summary, concept maps represent an important contribution from cognitive psychology and education, articulating theory and pedagogical practice. Their effectiveness depends on teacher mediation, active student participation, and integration with clear educational objectives. Several studies indicate that the use of CMs contributes significantly to the clarity and depth

of content understanding, as visualizing the relationships between concepts promotes meaningful learning. In addition, student motivation tends to increase, as visual representation makes the learning process more interactive and attractive. The possibility of transferring knowledge to new situations is another important benefit, especially in an educational context marked by constant change.

In mathematics education, concept maps help overcome difficulties related to abstraction and rote memorization. They act as bridges between abstract knowledge and concrete understanding, facilitating the logical organization of ideas. Despite their advantages, CMs also have limitations. For example, their evaluation can be subjective, and their construction can be difficult for beginners, requiring adequate teacher guidance. Still, when used well, they are powerful tools for promoting meaningful learning and critical reflection.

Concept maps encourage collaboration, critical thinking, and student engagement. However, their effectiveness can vary according to individual and contextual factors, which makes assessing the impact of this tool even more challenging. The structure of maps involves concepts connected by linking words, forming a visual hierarchy that organizes knowledge, and this organization favors the identification of gaps and the personalization of teaching.

In this sense, Novak states that concept maps "are tools that help make students' cognitive structures explicit, revealing the depth of understanding and the relationships between concepts" (NOVAK, 2010, p. 34).

The analysis of the maps allows us to visualize the evolution of learning and the development of relevant skills. Souza et al. emphasize that "the teacher is the mediator, guiding and learning at the same time, overcoming the limits of learning that come only from theory" (SOUZA et al., 2019, p. 202), reinforcing the importance of innovative methodologies in teacher training.

Despite the benefits, there are challenges associated with the use of this tool. Correia and Nardi point out that the construction of maps requires mastery of technique and concepts, imposing different cognitive loads on the student (CORREIA; NARDI, 2019). Even so, the construction of maps favors reflection, argumentation, and communication, which are fundamental skills for academic and professional life.

The process of constructing maps encourages reflection, logical argumentation, and the development of communication skills, which are considered fundamental throughout academic and professional life. This statement reinforces the importance of adopting innovative methodologies in teacher training and everyday school life. Concept maps also stimulate collaborative work, critical thinking, and reflection, making the learning process more engaging. However, their effectiveness may vary according t nd individual factors such as motivation, prior knowledge, and study conditions.

The structure of concept maps involves concepts connected by linking words, forming a visual hierarchy that organizes knowledge and allows learning gaps to be identified. This process facilitates the identification of students' prior knowledge and enables the personalization of teaching, making learning more efficient and meaningful. Thus, assessment through maps allows

for a broader understanding of learning, overcoming the limitations of traditional assessments.

One of the main indicators of meaningful learning is the ability to integrate new knowledge into the previous cognitive structure. Moreira states that "the important thing is not whether this map is right or wrong, but whether it provides evidence that the student is learning meaningfully" (MOREIRA, 1997, p. 7-8). This perspective shows that meaningful learning manifests itself through lasting changes in the way students organize and apply their knowledge.

The assessment of meaningful learning requires tools that go beyond traditional models and consider complex skills such as critical thinking, synthesis, and problem solving. In this scenario, concept maps show great potential for promoting and assessing learning in an integrated and contextualized way, contributing to a more meaningful education that is aligned with contemporary demands. The discussion on assessment includes different methods, such as standardized tests, performance assessment, and formative and summative assessment. Traditional tests cannot fully capture skills such as creativity and critical thinking. Formative assessment, on the other hand, offers continuous feedback and allows for pedagogical adjustments, while summative assessment provides a final synthesis of learning.

Technological advances, perspectives, and challenges in implementing meaningful learning

Technological advances and the expansion of digital tools have brought about

profound changes in the contemporary educational landscape, transforming not only the resources available for teaching, but also methodologies, forms of interaction, and possibilities for knowledge construction. In this context, the integration of concept maps into digital technologies emerges as a promising strategy to make the teaching and learning process more interactive, meaningful, and aligned with the demands of today's society. The incorporation of these tools enables the creation of more dynamic and participatory learning environments, in which teachers and students take active roles in knowledge construction.

Concept maps are a tool capable of organizing knowledge into networks of relationships, promoting a more integrated understanding of content. As Junqueira and Maximiano state, "since a concept map presents content as a network of conceptual relationships, this structure allows the teacher to have a more integrated mastery of this knowledge" (JUNQUEIRA; MAXIMIANO, 2020, p. 103-104). This feature breaks with the traditional linear organization of content, typical of expository approaches, and promotes the visualization of relationships between concepts, contributing to deeper and more meaningful learning.

The use of digital tools for building concept maps considerably expands their pedagogical possibilities. Collaborative software and platforms allow you to create, edit, and share maps intuitively, integrating multimedia resources and promoting real-time collaboration. These technologies make the process more accessible and attractive to both teachers and students, encouraging engagement and active participation. However, rapid technological evolution also brings important challenges, such as ine-

quality in access to technologies, the need for adequate training for teachers and students, and concerns about data security and privacy. These aspects must be considered so that the benefits of innovations are effectively achieved and distributed equitably.

The personalization of teaching is one of the pillars of contemporary education and finds an important ally in concept maps. Recognizing that students have different learning styles, rhythms, and interests is essential for building more effective and motivating educational experiences. Adapting concept maps to the characteristics of learners allows for the exploration of different levels of complexity and formats, promoting interest and engagement. In this sense, Dantas, Silva, and Borges emphasize that "teachers need, in addition to a good theoretical foundation, tools and strategies that lead to the goal they expect for teaching" (DANTAS; SILVA; BORGES, 2018, p. 198-199). Thus, concept maps are tools that contribute to the construction of more flexible and student-centered pedagogical practices.

Collaborative work is a fundamental element in the use of concept maps, as collective construction favors the exchange of experiences, the negotiation of meanings, and the development of social skills. Beber and Pino point out that "mastery of the conceptual mapping technique was expanded with the development of CMs in pairs of students" (BEBER; PINO, 2019, p. 123), highlighting the importance of social interaction in the learning process. Collaboration promotes communication, argumentation, and problem solving, which are essential skills for the comprehensive education of students.

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The expansion of concept maps to different areas of knowledge demonstrates their flexibility and interdisciplinary potential. In the humanities, they allow us to understand historical, literary, and philosophical relationships; in mathematics, they facilitate the visualization of relationships between theorems and abstract concepts; in the social sciences, they contribute to the analysis of complex phenomena. Queiroz et al. state that "the representation of knowledge helps to transform skill into method" (QUEIROZ et al., 2018, p. 82-83), emphasizing the role of concept maps in the organization and explicitation of knowledge.

The collective construction of concept maps also favors the negotiation of meanings and the sharing of interpretations. Ferrão and Santarosa highlight that "when maps are shared, this plurality of interpretations can be taken as an instrument for negotiating meanings" (FERRÃO; SANTAROSA, 2020, p. 12). This practice promotes the development of argumentative skills and the ability to consider different points of view, contributing to the formation of critical and participatory citizens.

The integration of educational technologies requires attention to ethical and privacy issues, especially with regard to the collection and use of student data. It is necessary to ensure transparency, informed consent, and adequate security measures, ensuring trust in the educational environment. In addition, the implementation of meaningful learning requires changes in pedagogical practices, often facing resistance stemming from the tradition of teaching centered on content transmission.

Ausubel's theory of meaningful learning remains a fundamental reference in this process, stating that learning occurs when new information relates to the student's prior knowledge. Continuing teacher training is therefore essential for the adoption of these methodologies, enabling teachers to develop skills to integrate theory and practice and promote more meaningful learning experiences. The future prospects for education point to the personalization of teaching, the use of artificial intelligence, and the valorization of teaching by competencies, such as critical thinking, collaboration, and digital literacy. In this scenario, concept maps remain strategic tools for integrating methodologies, technologies, and meaningful learning, contributing to the construction of a more inclusive, collaborative, and student-centered education.

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