

## **Omnilateral Training: contributions from the areas of mathematics and natural sciences in integrated high school**

### ARTICLE

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### Abstract

This text seeks to identify and discuss contributions of pedagogical practices developed in the disciplines of mathematics and natural sciences for a possible *omnilateral* training of students in integrated high school. This is a literature review carried out in 4 databases (Science Direct (Elsevier), Scopus, Scielo and Google Scholar) with the period from 2013 to 2023 as a time frame. After applying inclusion and exclusion criteria, 26 articles were selected scientists who contributed to answering the following research question: "How do exact science subjects contribute to the *omnilateral* training of students in integrated high school?". The results found showed that the integration between theory and practice is essential for there to be a possibility of *omnilateral* training of students. However, a gap was identified in this researched field, highlighting the scarcity of studies that relate the theoretical references of teaching exact disciplines with the concept of *omnilateral* training of students.

**Keywords:** *Omnilateral* Training. Integrated High School. Pedagogical practices.

### **Formação *Omnilateral*: contribuições das áreas de matemática e ciências da natureza no ensino médio integrado**

### Resumo

Este texto busca identificar e discutir contribuições de práticas pedagógicas desenvolvidas nas disciplinas de matemática e ciências da natureza para uma possível formação *omnilateral* dos estudantes no ensino médio integrado. Trata-se de uma revisão da literatura realizada em 4 bases de dados (*Science Direct* (Elsevier), *Scopus*, *Scielo* e *Google Scholar*) tendo como corte temporal o período de 2013 a 2023. Aplicados os critérios de inclusão e exclusão, foram selecionados 26 artigos científicos que contribuíram para responder a seguinte pergunta de pesquisa: "Como as disciplinas de exatas contribuem para a formação *omnilateral* dos estudantes no ensino médio integrado?". Os resultados encontrados apontaram que a integração entre teoria e a prática é essencial para que haja uma possibilidade de formação *omnilateral* dos estudantes. Contudo, foi identificada uma lacuna nesse campo pesquisado, destacando-se a escassez de estudos que relacionem os referenciais teóricos do ensino das disciplinas de exatas com o conceito de formação *omnilateral* dos estudantes.

**Palavras-chave:** Formação *Omnilateral*. Ensino Médio Integrado. Práticas Pedagógicas.

## 1 Introduction

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The contemporary educational scenario has been marked by the incessant search for approaches that promote the acquisition of knowledge and the integral development of students through the construction of knowledge. In this context, the concept of *omnilateral* education arose, initially used by Karl Marx as a reference to the educational system, because the factory system gave birth to the education of the future, seen as a possibility both to increase social production and to form fully developed human beings.

Thus, *omnilateral* education aims to provide an education that goes beyond disciplinary boundaries and promotes the holistic growth of individuals, promoting an education rooted in the unitary school proposal advocated by Antonio Gramsci (one that offers equal rights to all students), overcoming educational dualism and based on the ability to create an intellectual environment for all students. This ensures that students become familiar with collective discipline and develop notions and skills that promote their intellectual growth.

In this perspective of transformative education for life, the school should be unique, balancing and combining technical and manual training with intellectual development, equally valuing practical and theoretical skills and proposing a broad curriculum in cultural, ethical and social knowledge, essential for critical and conscious citizens.

The concept of Integrated Secondary Education (EMI) has thus emerged as an educational modality that seeks to implement this concrete way of looking at education, offering students broader and more integrated learning opportunities.

Having presented this initial scenario, this article is the result of a literature review that discusses the theme of "*omnilateral* training" in EMI, through pedagogical practices developed in the areas of Mathematics and Natural Sciences. The aim of this study was to select articles that discussed the topic between 2013 and 2023, linked to the databases

searched: Science Direct (Elsevier), Scopus, Scielo and Google Scholar. It is justified by the need to discuss and understand curricular integration and teacher performance as necessary contributions to the comprehensive and emancipatory education of students in the current EMI proposal.

Corroborating this idea, the authors Sá, Jordane and Giraldo (2022) argue that integration in EMI will only be effective if we take interdisciplinarity as the central axis in the organization of pedagogical work. Therefore, the integration of mathematics and natural sciences with other subjects, especially those in the technical area, can play a fundamental role in the formation of critical-reflective, conscious and responsible individuals. This approach provides a broader understanding of the world and the processes that govern it, as well as promoting the development of skills and competencies for exercising citizenship and entering the job market.

Therefore, in order to present the recent evolution of publications related to "omnilateral education" developed in the area of exact sciences, we have prepared this study which presents a comprehensive overview of scientific productions that discuss integral education in the teaching process developed at EMI.

## **The relationship between work and education: historical context**

The relationship between work and education is intertwined with history itself, and this relationship was developed by man as a way of staying alive, through his ability to transform nature for his own benefit to ensure his survival, which differentiates him from other living beings (Frigotto, 2016).

To understand this historical context, it is important to recognize the significant changes that have occurred over time. For Dermeval Saviani, man transforms nature through work in order to meet his needs, improve his living conditions and stay alive. Thus, man differs from other animals in his ability to think and produce his own livelihood through bodily organization, consequently producing his material life. Historically, all their work activities have always been carried out in groups, and everything that was collected was shared among the members, taking from nature only what was necessary for their survival.

In other words, men worked and appropriated the means of production collectively, perfecting their skills over time. Thus, at the same time as man works, he educates himself.

Historically, education was seen as separate from the world of work, but with the change in the mode of production and the appropriation of land, man's main means of survival, there was a division of social classes. Consequently, education was also divided, with one part focusing on academic knowledge and theoretical understanding, identified as the education of free men, of the ruling class (propaedeutics), and another education for the disadvantaged of the non-dominant class, which was assimilated to the work itself (vocational).

This division of education underwent a new transformation with the Industrial Revolution at the end of the 19th century, bringing about a paradigm shift that gave greater importance to practical skills and professional training, because as society became more complex and technology-oriented, the need for a more integrated education became more evident. In one of his many works on society, Karl Marx argues that work itself is a vital educational experience, and that it is through work that individuals acquire not only practical skills, but also a deeper understanding of social structures and class dynamics.

With this new perspective and the demand for qualified labor, various proposals for education were put forward in several countries, including Brazil, to meet the needs of industrial development. According to Fonte (2018, p. 7), "the Marxist proposal is perhaps the most advanced and systematized alternative in our fight against a project that is limited to preparing and qualifying workers based on employers' interests". However, other authors, such as Gaudêncio Frigotto, point out that the interests went beyond valuing work or the worker, as the focus was always on keeping the workforce strong enough to serve the interests of production.

In this way, the interests of production, discussed here, go further and expand into the field of education, remaining focused on the interests of the ruling class, which sees education as a new form of domination over the working class. For Ciavatta (2019, p. 145), "educational processes take place not only at school, but also in informal spaces of education for work, for citizenship, for culture, in social movements and their organizations".

For the author, it is necessary to be aware that professional training is not just training to carry out manual activities, but a construction of education as human formation, capable of providing the ability to expand knowledge and worldview. Thus, "like work, human education must be understood and practiced in relation to the concepts of the totality of social life and work as a structuring activity of human life in all its potential, dignity and ethics" (Ciavatta, 2019, p. 145).

Having said that, it is worth pointing out that, historically, education has been increasingly dual, with a huge gap between general education and vocational education, serving only the interests of the dominant capitalist society. Contrary to this conception of comprehensive training, Ramos (2014, p. 94) comments that "the concept of comprehensive human training suggests overcoming the human being historically divided by the social division of labor between the action of executing and the action of thinking, directing or planning". In this way, it can be said that education should cover all social classes in a single integrated way, giving the working class in particular access to technological, cultural and scientific knowledge, in order to develop professional skills that contribute to production processes and promote the formation of people who are better prepared to occupy their place in the social division of labor.

In the discussions of the mobilized authors, it was possible to observe that throughout history, the relationship between work and education has always accompanied man, whether for reasons of survival or political interests. In this search for better working conditions and coexistence in society, a new type of education has emerged called Secondary Technical Professional Education (EPTNM) or simply EMI, which seeks to overcome the educational challenges imposed by the current conditions of production in contemporary society.

## **Integrated High School: curricular integration aimed at *omnilateral* education**

EMI is a type of education linked to Professional and Technological Education (PTE) and emerged as an attempt to overcome the duality that exists in Brazil between basic education and professional education. Thus, "it is no exaggeration to say that

professional and technological education (PTE) has accompanied man since ancient times, when professional knowledge and techniques were transferred through observation, practice and repetition" (Vieira; Souza Junior, 2016, p. 153).

Decree No. 5.154/2004 revoked Decree No. 2.208, of April 17, 1997, and defined new guidelines for the organization of Vocational Education. In its text, more specifically in Article 39, it is highlighted that "Professional Education is clearly characterized as "integrated with the different forms of education, work, science and technology, with the aim of leading citizens to a permanent development 'of skills for productive life' in the society of work and knowledge" (Brasil, 2004, p. 2). Thus, PTE seeks to promote the comprehensive training of students, providing mental or intellectual, physical and technological conditions, with the aim of preparing them for life and work, simultaneously, through a curriculum that articulates the bases of essential knowledge for polytechnic and *omnilateral* training (Bessa *et al.*, 2020).

For Silva *et al.* (2019), an integrative education must articulate and achieve the three fundamental dimensions for life in society: work, science and culture, so that the student is prepared to live in society. Corroborating the author, Roberto and Marques (2018) assert that, in order to overcome the duality that still exists in education, EMI must guarantee integrality between basic and professional education, offering scientific content that contemplates the development of man in an integrated manner, thus providing a complete education.

In this way, the EMI, in its pedagogical proposal, recognizes that "*omnilateral* education would be one in which man would feel complete, because it would conceive of man as a whole (physical, mental, cultural, social, affective, political, etc.). It would be an education that overcomes the division between manual and intellectual labor" (Roberto; Marques, 2018, p. 22). The authors also comment that, for a teaching proposal that seeks to offer true integration, it is not convenient for there to still be a dichotomy between basic subjects and technical subjects. Therefore, it is believed that only by integrating the scientific content essential for human development, applied in basic education in order to



complete professional training, would it be possible to overcome the existing duality. This combination of knowledge would provide students with a complete education.

In view of these considerations, it is understood that EMI needs to have effective curricular integration between theory and practice, with the aim of promoting a more complete and comprehensive view of knowledge, in order to enable comprehensive training. Such training must be able to develop students' skills and competencies that go beyond mastering the specific concepts of each discipline and aim to develop their capacity for critical, collaborative thinking, effective communication and intellectual autonomy. In other words, a polytechnic or *omnilateral* education that is "articulated to the knowledge base of the dimensions of life concerning the mental or intellectual, physical and technological conditions of the student" (Bessa, 2020, p. 5).

This vision of curricular integration, which seeks to bring theory and practice closer together and provide students with an integral education, is in line with the points made by Ciavatta (2014), who asserts that the articulation of EMI with PTE must seek to overcome the historical struggle between social classes, as a way of offering an education in the polytechnic and *omnilateral* conception. Consequently, an integral education would also assume, from a conceptual point of view, the search for "overcoming the structural dualism of Brazilian society and education, the division of social classes, the division between training for manual work or intellectual work, and in defense of democracy and public schools" (Ciavatta, 2014, p. 197-198).

However, PTE integrated with secondary education, according to Roberto and Marques (2018, p. 30), "is not a guarantee of integration and the dichotomy may still be present, if general education is not something inherent to professional education. Integration is needed, in the full sense of the word, to become unique, total, whole." Thus, EMI presents itself as an ethical-political possibility for overcoming existing contradictions, in order to establish itself as a path towards a more formative education, where work is seen as an educational principle and not as a job or labor work, thus promoting the approximation of its historical, ontological and ethnic-political dimensions (Silva *et al.*, 2019).

As a result of these discussions, it has become possible to state that, regardless of the dualism historically present in education, PTE has the potential to prepare students for both work and life in society, provided that the proposal for curricular integration materializes in an interdisciplinary and collective way at EMI, which will certainly point the way towards *omnilateral* education.

## 2 Methodology

To develop this study on the contributions of the areas of Mathematics and Natural Sciences in EMI to students' *omnilateral* education, searches were carried out in the Science Direct (Elsevier), Scopus, Scielo and Google Scholar databases. Initially, exploratory tests were carried out on the platforms using the descriptors: "*omnilateral* education"; "pedagogical practices"; "mathematics" and "natural sciences", separately, in Portuguese, considering the title, year, abstract and keywords. The descriptors were then translated into English and Spanish and the search was repeated.

In order to expand the number of findings and achieve greater precision of the research objectives, combinations were made between the descriptors to carry out the searches using the terms "AND" and "OR" as follows: ("*omnilateral* education" OR "pedagogical practices"); ("*omnilateral* education" OR "mathematics"); ("*omnilateral* education" OR "natural sciences"); ("*omnilateral* education" OR "pedagogical practices" OR "mathematics" OR "natural sciences"); ("*omnilateral* education" AND "pedagogical practices" AND "mathematics" AND "natural sciences") in the search engine fields of the platforms.

The selection criteria adopted for the articles found were as follows: 1) empirical research; 2) contain the topic in the title, abstract or keywords; 3) be a scientific article; 4) meet the time frame of 2013 to 2023; 5) published in Portuguese, English or Spanish; 6) free and open access. Exclusion criteria were: 1) duplicate articles; 2) restricted access; 3) articles that did not meet the other inclusion criteria. The selected articles were then



selectively read and those which were unclear about the object of study and the results found were excluded.

In these analyzed texts, the criterion of directed reading was also applied, analyzing whether they would answer the following research question "How do the disciplines of the exact area contribute to the *omnilateral* formation of students in integrated high school?". This led us to read the introduction and the concluding remarks, as a way of identifying whether the articles actually addressed the objective, the problem and the discussions within the disciplines of mathematics and natural sciences, as well as presenting some contribution to the *omnilateral* education of EMI students through pedagogical practices used in the field of exact sciences.

After the process of identifying and analyzing the articles found, 26 articles were selected that met the objective of this research. In this selection, a greater number of papers were identified that dealt with the area of mathematics, while in the area of natural science the articles were more restricted to discussions of theory than of practice itself. It was also found that the number of papers published on this topic increased from 2017 onwards, so our analysis focused more on this period.

Having explained the methodological procedures adopted, we now present the discussions held and the results found.

### 3 Results and Discussion

Using the legislation, we can see that the relationship between theory and practice is "ensured in the curriculum and in pedagogical practice, aiming to overcome the fragmentation of knowledge and the segmentation of curricular organization" (Brazil, 2012, Art. 6). However, we see that in practice, this relationship is more rigorously addressed in the mathematics subject, while in the area of natural sciences the focus tends to be more on theoretical concepts, without much concern for practical subjects, although they are mentioned.

Therefore, the proposal described in the legislation to work on theory and practice seeks to integrate propaedeutic and/or technical subjects through interdisciplinarity, bringing theoretical content closer to the technical content of students' daily lives. However, for this to materialize, it is essential that pedagogical practice is efficient, contextualized, flexible and interdisciplinary, capable of developing educational strategies that lead to an understanding of the meanings of theoretical-practical-professional integration, thus contributing to the development of the teaching and learning process and, consequently, the *omnilateral* education of students.

### 3.1 Integrated Secondary Education and *Omnilateral* Training: paths and challenges

The discussion about educational duality in Brazil, characterized by the division between technical education - aimed at training workers - and propaedeutic education - aimed at preparing students to enter higher education - is addressed by Roberto and Marques (2018). They highlight the historical consequences of education in the country, where slavery, social exclusion, economic inequality and a lack of emphasis on basic education are pointed out as the central origins of this duality.

Emphasizing the importance of integration and interdisciplinarity in educational practices, involving the integral formation of the student and the development of skills and competencies to face the challenges of contemporary society, Santos *et al.* (2018) point out that educational practice must be conscious, planned and intentional, capable of promoting an integral formation. The authors also stress the importance of interdisciplinarity and research as educational principles capable of contributing to the construction of new knowledge.

Understanding EMI as a teaching modality that seeks to integrate academic and technical aspects, and highlighting its ideological and philosophical origins based on Marxist principles, capable of promoting the integral formation of the student, Silva and Oliveira (2018) highlight the challenges of implementing EMI due to the lack of clarity in the official documents that regulate this teaching modality. The authors also emphasize the importance of training teachers who can articulate general and technical training, thus

promoting polytechnic education and an *omnilateral* training of students that is capable of developing all human potential. In addition, Silva and Oliveira (2018) emphasize the need for a political and ideological commitment to the effective implementation of EMI, as well as the importance of intellectual, moral and financial investments in this process.

Discussing the need to integrate work, science and culture in education, particularly in EMI, Silva *et al.* (2019) argue that historically this stage has focused on preparing students for the job market, with a focus on technical skills. However, given the changes in the job market, the authors argue in favor of an education that prepares students for life in a broader way. It is therefore necessary to consider the importance of a more comprehensive education for secondary school, taking into account individual needs and the knowledge built up throughout history, since the integration of general and specific education is emphasized as a socio-cultural and economic necessity for comprehensive education to take place.

The proposal to unify the subjects of Physics, Chemistry and Biology in a single block, called the Nature Sciences training itinerary, after the curriculum reform, is the subject of research by Oliveira (2020). The author points to an increase in concern about the teaching of Physics, a subject already considered difficult and demotivating by students, which could become even more superficial and fragmented with this change.

The author argues that the teaching of Physics requires new pedagogical paths to meet the demands of contemporary basic education. As an interdisciplinary subject that dialogues with various technical disciplines, Physics promotes the interpretation of natural phenomena, stimulates a critical and investigative sense, as well as developing a real vision of everyday situations related to the world of work.

In a study carried out with students on a Cookery Technical Course in the Professional Youth and Adult Education program (PROEJA) at the Federal Institute of Education, Science and Technology of Bahia (IF Baiano), the author sought to establish a dialogue between Physics content and the practical activities developed in the technical disciplines. This promoted the integration of scientific knowledge with practice and made

contributions to the *omnilateral* education of students, capable of impacting and transforming the social environment (Oliveira, 2020).

As a methodological resource, the author clarifies that social media were used to promote the socialization of the work developed and bring students closer to the content of Physics and technical disciplines, as well as the knowledge produced by science. Oliveira (2020) also comments on the importance of analysing the challenges faced and promoting integrative and interdisciplinary actions that encourage the contextualization of theory and practice.

In these contexts, the persistent duality in PTE in Brazil, with propaedeutic training aimed at the elite and professional training of a welfare nature for workers, was addressed by Bessa *et al.* (2020). The authors discuss the historical evolution of PTE and the changes in Brazilian educational policies, such as the introduction of the National Common Curriculum Base (BNCC), which, although it sought to overcome inequalities, was seen as prescriptive and imposing. Bessa *et al.* (2020) also highlight the importance of interdisciplinarity in PTE as a way of promoting a broad and critical education for students. For the authors, interdisciplinarity is a challenge for students, educators and regulatory agents, given the superficial way in which it is approached in the guiding documents of our education. They argue that interdisciplinarity, when applied in education, goes beyond the simple integration of disciplines and aims to promote the construction of knowledge in a broad and critical way.

Discussing the construction of EMI in Brazil through regulation, Souza and Benites (2021) highlight the need to overcome the duality between preparatory education and vocational education, through a historical study and the discussions that led to the creation of Decree No. 5.154/2004, which regulated EMI. The authors point out the importance of public educational policies that aim to integrate basic and vocational training organically in the same curriculum. In addition, Souza and Benites (2021) discuss the concept of polytechnic and *omnilateral* education, based on the thoughts of Karl Marx and Antonio Gramsci, where education should seek to integrate all dimensions of life, such as work, science, culture and technology, into the training process.

Still in these discussions, for Souza and Benites (2021) EMI has the potential to provide students with an integral and emancipatory education. However, for this to happen, it is essential that EMI is not subject to the rules of capitalism and the actions of the state, as it needs to go beyond the demands of the dominant classes that own the means of production.

### 3.2 Teaching mathematics and natural sciences in PTE: contributions to *omnilateral* education

Santos, Nunes and Viana (2017) propose an analysis that promotes the interdisciplinarity of the mathematics curriculum with technical subjects, seeking to identify which mathematical contents can help teachers in this process, adding technical-professional characteristics without losing their fundamental specificities. However, the authors make it clear how complex this analysis is and present authors who conceptualize the need for the curriculum to be built from cultural aspects, including teaching subjects, levels and workload, with the teacher being responsible for its implementation.

It is argued that this becomes a problem for Brazilian education, since in a country with a continental area it is practically impossible to offer a single curriculum, given the great cultural diversity that exists. It is also emphasized that the problem becomes more evident when we look at PTE, which proposes curricular integration between theory and practice, taking into account the profile of the professional we want to train and the objectives set by the course offered.

A study carried out on a technical course in agriculture identified that the objectives proposed by the course project under study were different to those governed by legislation, and did not propose curricular integration between the subjects of basic education and those of technical education, thus compromising the students' comprehensive training. The aim was to find out whether there was a need for mathematics to be interdisciplinary with the technical area, in order for the students' learning to be effective. At the end of the study, the authors concluded that mathematical content was essential for the teaching of technical subjects at all stages of the Agricultural Technician course. However, there was no

evidence of interdisciplinarity and contextualization between the two areas, thus leaving a gap between the objectives proposed for PTE in all its areas of activity.

Andrade and Viana (2017) analyzed an evaluation process applied in experimental chemistry classes at EMI, which aimed to investigate the conceptions of mediating evaluation and innovative practices as pedagogical proposals capable of forming and making teaching more interactive, dynamic and reflective, stimulating students and expanding their critical capacity and curiosity. The authors draw attention to the evaluation process as a reflective form of teaching practice itself in the construction of students' critical and reflective knowledge. They emphasize that the investigative process should start from a historical context of the evaluation process and how each of the periods investigated should approach the students' learning process.

The work of Cavalcanti and Queiroz (2018) sought to understand chemistry teachers' conceptions of their teaching practice applied to experimental activities carried out in a teaching laboratory, where their pedagogical and epistemological objectives are questioned. The authors point out that the use of experimentation in science teaching has been recognized by philosophers since the 18th century and that it was included in curricula from the 19th century onwards, but it was only consolidated as a teaching strategy in the mid-20th century with the intensification of new studies that defended the importance of knowledge of scientific methods linked to scientific concepts. Therefore, for Cavalcanti and Queiroz (2018), experimental practices in laboratories would develop students' critical thinking in relation to social issues and new future situations.

The authors add that the consolidation of the integration process between experimental practices and the curriculum depends on the teachers' conception of science, thus influencing the way they prepare their lessons, activities and experiments to be applied in the classroom. Therefore, the use of experiments in the classroom goes beyond understanding what science is, but has a technical and citizenship training character, bringing closer the importance that science has for the development of the modern world, especially for those who will work with it professionally.



Thus, Cavalcanti and Queiroz (2018) conclude that many practical chemistry classes are carried out, but with little diversity in objectives, and point out that the chemistry teachers who took part in the study understand that experimental activities are tools for professional training and not for *omnilateral* training.

In a study in the field of science, with an emphasis on Biology, Lima, Amorim and Luz (2018) discuss three types of experimental activities: Demonstration, Verification Activity and Investigation Activity. The authors present the characteristics and specific objectives of each of these modalities, highlighting the importance of experimentation in biology teaching, the need to promote meaningful learning and the relevant role of the teacher as a mediator of knowledge. Lima, Amorim and Luz (2018) mention challenges in the use of practical activities in biology teaching, such as the lack of preparation in teacher training and structural and curricular limitations. The authors discuss the exploration of different approaches to experimental activities and the importance of promoting meaningful learning for students.

Simonini and Citolin (2019) discuss the importance and need for a reflective and dialogical approach in education and in the teacher's pedagogical practice in the teaching and learning process. For the authors, pedagogical practice goes beyond simply transmitting knowledge. They emphasize that there must be interaction between teacher and student, capable of developing autonomy and the construction of knowledge. Simonini and Citolin (2019) discuss the idea that successful pedagogical practices are related to the skills of the teacher, who must act as a mediator in the teaching process, promoting the development of students' skills and creativity. Teachers don't just teach subjects; they also teach values and attitudes. Therefore, for pedagogical practice to be successful, it must be based on ethical principles.

Active Methodologies (AMs), explored as integrative pedagogical practices with a focus on the use of digital technologies in Technical Professional Education at Secondary Level (EPTNM), are discussed by Costa and Coutinho (2019). The authors present the experiences of the teachers taking part in the research, who use AMs to find an interdisciplinary way of involving students in the teaching and learning process. This is

done using analog games, gamification, text production in different contexts and digital technologies, stressing that the emphasis of the AMs is on promoting student motivation, so that these AMs stimulate active participation, integration between different curricular components and the development of skills in a more comprehensive way, considering the student as a historical, political, social and cultural being.

The challenges faced in implementing interdisciplinarity in the educational context are also the focus of research by Silva, Araujo and Ferreira (2020). The authors state that the term interdisciplinarity is relevant in academic discussions, but its definition is not unique and stable, allowing for different interpretations. It is clear that, in the current educational scenario, it is crucial to rethink the role of the school in relation to teaching and learning.

According to the authors, it is necessary to overcome the fragmented teaching model, based on memorizing formulas and ready-made answers, which no longer meets society's expectations, since teaching practice should promote more dynamic teaching and a more meaningful interaction between students, teachers and knowledge. However, the lack of teacher training in this area is one of the main challenges. Silva, Araujo and Ferreira (2020) draw attention to the importance of continuous discussions about the teaching process, which seeks to meet students' expectations, incorporating interdisciplinary practice in a continuous manner between disciplines, as these must consider that practice demands new methodological options and not all teachers are prepared to implement them.

Pimentel, Souza and Sá (2021) propose to understand the profile of mathematics teachers who share experiences of mathematics education in PTE. The authors defend curricular integration as a way of overcoming the fragmentation of knowledge caused by the expansion of new means of production. They highlight the importance of interdisciplinarity as a proposal for integrating basic subjects with technical subjects in PTE, with a view to better preparing students for the world of work. In addition, they argue that curriculum integration does not mean ignoring the particularities of each discipline, but

rather seeking equivalence between education and the world of work, in order to overcome the dichotomy present in the traditional education system.

Interdisciplinarity is seen as a solution to the fragmentation of knowledge, but there are several obstacles and challenges that hinder the implementation of this action, especially in the disciplinary organization of content. As such, the knowledge of teachers working in PTE must go beyond the didactic aspect and take on the role of effectively preparing students for their future professional careers. Therefore, in order to achieve this goal, it is necessary to have an epistemological responsibility that aims to improve the quality of teaching in the area of mathematics (Pimentel; Souza; Sá, 2021).

The implementation of Integrative Pedagogical Practices (IPPs) is of the utmost importance in this quest to overcome both educational duality and fragmentation in student education, since the dual form of education hinders the student's integral development, especially in PTE, according to Cardoso *et al.* (2022), who claim that there are contributions and possibilities for achieving students' integral education in EMI, through IPPs. For the authors, the IPPs are a means of promoting a more complete and emancipatory education, aimed not only at acquiring knowledge, but also at developing critical thinking and the ability to transform the reality experienced by students. Cardoso *et al.* (2022) recognize that there are several challenges in implementing the IPPs, including the organization of pedagogical time, the lack of specific training and the need for institutional programs that promote the discussion and integration of curricular practices. However, they defend the adoption of IPPs as a path towards a more complete, *omnilateral*, integral and/or polytechnic education.

For Morais and Gitirana (2022), the integration of preparatory and technical subjects in PTE, in an interdisciplinary way in math classes, contributes to more meaningful learning for students, overcoming the traditional division between general and technical knowledge. However, the authors point out divergences in the curricular distribution of mathematics and technical subjects that work on mathematical content, and propose rethinking the curricular conditions for integration. They suggest collaborative and interactive work between teachers in the preparatory and technical areas to discuss ways

of working on content in an integrated way. It is of the utmost importance that mathematics teachers use technical resources specific to professional disciplines in their classes, developing action schemes to master the technical theme and thus establish relationships that contribute to student learning.

The inclusion of Digital Information and Communication Technologies (DICT) as a mediator in the teaching-learning process through pedagogical practices in Technical Professional Education at Middle Level (EPTNM) in the perception of Science and Mathematics teachers, with a view to estimating their potential or limitations, is discussed by Machado, Ramos and Ortega (2022). For the authors, 21st century students are considered digital natives and belong to a generation that grows up connected to the internet. Therefore, the education they expect must be dynamic, participatory and active, requiring teachers to have greater technological knowledge in order to plan their lessons and act in the face of a new learning theory, the Connectivity theory, even though there is no consensus on it as a learning theory.

The results found by the authors indicate that the majority of mathematics and natural sciences teachers who took part in the research believe that the use of DICT contributes to the teaching process, making lessons more attractive and, consequently, stimulating student participation. It was also pointed out that the majority of teachers have received appropriate training from their institutions. Another important point is that these teachers see the incorporation of DICTs into their teaching practice as positive (Machado; Ramos; Ortega, 2022).

Reflecting on how Brazilian teachers who teach mathematics have taken on work as an educational principle in Technical Professional Education at Middle Level (EPTNM), Sá, Jordane and Giraldo (2022) revisit the conceptual axes of Brazilian PTE and ask: What is this work that we should adopt as an educational principle? Why choose work as an educational principle?

The authors present Mathematical Modeling as an educational principle in mathematics classes, according to the EPTNM Curriculum Guidelines. They describe two experiences: one with students from the Technical Course in Occupational Safety, who

analyzed projects on safety in butchers and meatpackers, comparing the costs of Personal Protective Equipment (PPE) with the costs of accidents; and the other with students from the Technical Course in Industrial Automation, who created a project to alert people to natural disasters, inspired by the dam collapse in Mariana (MG). Both experiences go beyond utilitarian mathematics, raising awareness of social issues and the importance of safe work. This critical and emancipatory approach is in line with the theoretical assumptions of EPTNM, overcoming the dichotomy between manual and intellectual work and emphasizing the political meaning of mathematics education.

According to Sousa and Maciel (2023), the possibility of implementing *omnilateral* education in the Brazilian context, especially within the scope of PTE, comes up against challenges of a material, structural, normative, political and didactic-pedagogical nature. For the authors, this proposal must be implemented gradually, considering the conditions for its implementation and effectiveness, given the need to overcome the disciplinary logic in pedagogical practice, seeking integrative practices that promote the interaction of disciplinary knowledge for the production of supradisciplinary knowledge. In other words, overcoming disciplinarity is essential for achieving the *omnilateral* education of students, from the perspective proposed by PTE.

## 4 Conclusions

After reading and analyzing the selected articles, we realized that the complexity of the relationship between work and education is very present in the 21st century, and the transformative role that this relationship has played throughout history is evident. Both Professional Technological Education (PTE) and Integrated Secondary Education (EMI) represent significant attempts to overcome these historical dichotomies in education, always seeking to provide a more complete and *omnilateral* education for students.

However, it is clear from the works analyzed that the proposal for *omnilateral* training in PTE and EMI still faces significant challenges, such as how to effectively integrate technical training with general education in order to promote a deeper

understanding of social structures and class dynamics. In addition, it is necessary to ensure that pedagogical practice is efficient, contextualized and interdisciplinary in order to achieve this integration in a complete way in these teaching modalities discussed.

Thus, we conclude that these reflections need to be more in-depth, encompassing discussions on the structural, political and normative problems that prevent PTE/EMI from becoming effective. It is therefore necessary to focus on overcoming the challenges and building a truly integrated educational system that prepares students not only for the job market, but also for full participation in the knowledge society.

Although research has shown progress in understanding the importance of integrating theory and practice, interdisciplinarity and overcoming the duality between basic and vocational education for an *omnilateral* education of students, there are still questions to be explored and challenges to be faced. When we carried out the searches for this work, we realized that although there is a considerable amount of research in this area in the databases, the amount of work involving the exact disciplines within the scope of PTE is still moderate, indicating a weakness in the reflections of this area, specifically in the context of *omnilateral* education.

There is a gap in the subject of "*omnilateral* education and pedagogical practices" developed in the areas of mathematics and natural sciences, especially in EMI. This suggests the need for further exploration of the subject, as this reflection could contribute more effectively to pedagogical proposals that lead to the integral formation of students, given that the exact disciplines have the potential to develop essential skills that lead to scientific thinking and logical reasoning.

We believe that this literature review can contribute to future discussions and/or academic productions that envision the process of *omnilateral* education for students in the PTE/EMI, especially through pedagogical practices developed in the area of exact sciences.

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