INTERNATIONAL SEVEN JOURNAL
OF MULTIDISCIPLINARY
ISSN: 2764-9547

A BRIEF DISCUSSION ON THE CTSA APPROACH AND ITS CONTRIBUTION TO PHYSICS CLASSES

UMA BREVE DISCUSSÃO SOBRE O ENFOQUE CTSA E SUA CONTRIBUIÇÃO PARA AS AULAS DE FÍSICA

UNA BREVE DISCUSIÓN SOBRE EL ENFOQUE CTSA Y SU CONTRIBUCIÓN A LAS CLASES DE FÍSICA

https://doi.org/10.56238/isevmjv4n5-009

Receipt of originals: 08/29/2025 **Acceptance for publication:** 09/29/2025

Andreia Klose Nadalon[1], Claucia Malavolta Tier[2], Rozemara Nich[3], Sabrina Klose Nadalon[4]

ABSTRACT

This article aims to list and highlight some theoretical assumptions regarding the Science-Technology-Society-Environment (STSE) approach, addressing several authors who address the topic, allowing for a connection between theory and practice in light of the STSE. The objective of this article is to reflect on issues related to the STSE and how these issues are experienced or planned by teachers who invest in professional development through continuing education. It was also possible to observe that the authors' thinking on this subject converges with the ideas of the authors. Reflecting on the theoretical precepts that fuel the discussion, it was observed that research-based teaching practice is the best way to evaluate and encourage changes in positioning, historically imposed on current schools.

Keywords: Science-Technology-Society-Environment. Physics. Teaching Practice.

RESUMO

Este artigo se propõe a elencar e destacar alguns pressupostos teóricos a respeito do enfoque Ciência-Tecnologia-Sociedade-Ambiente (CTSA), abordando diversos autores que tratam do tema, sendo possível estabelecer uma relação entre a teoria e a prática sob a luz do CTSA. O objetivo deste artigo está centrado em refletir sobre as questões relacionadas ao CTSA e como as questões referentes a ele são vivenciadas ou planejadas pelo professor que investe na qualificação profissional através da formação continuada. Também foi possível perceber que o pensamento dos autores a respeito deste assunto é convergente com as ideias das autoras. Ao refletir sobre os preceitos teóricos que alimentam a discussão observou-se que a prática docente pautada na pesquisa é o melhor caminho para avaliar e incentivar mudanças de posicionamento, historicamente impostos aos bancos escolares da realidade atual.

[1] Specialization in Mathematics Education. Universidade Regional Integrada do Alto Uruguai e das Missões. Brazil. E-mail: andreia-knadalon@educar.rs.gov.br
[2] Specialization in Mathematics Education. Universidade Regional Integrada do Alto Uruguai e das Missões. Brazil. E-mail: claucia-mtier@educar.rs.gov.br
[3] Master's Degree in Professional and Technological Education. Instituto Federal Farroupilha. Brazil. E-mail: rozemara-nich@educar.rs.gov.br
[4] Master's Degree in Public Policy. Universidade Federal do Pampa. Brazil. E-mail: sabrina-knadalon@educar.rs.gov.br

Palavras-chave: Ciência-Tecnologia-Sociedade-Ambiente. Física. Prática Docente.

RESUMEN
Este artículo tiene como objetivo enumerar y destacar algunos supuestos teóricos sobre el enfoque Ciencia-Tecnología-Sociedad-Medio Ambiente (CTSA), abordando varios autores que abordan el tema, permitiendo una conexión entre la teoría y la práctica a la luz de la CTSA. El objetivo de este artículo es reflexionar sobre cuestiones relacionadas con la CTSA y cómo estas cuestiones son experimentadas o planificadas por los docentes que invierten en el desarrollo profesional a través de la educación continua. También fue posible observar que el pensamiento de los autores sobre este tema converge con las ideas de los autores. Al reflexionar sobre los preceptos teóricos que alimentan la discusión, se observó que la práctica docente basada en la investigación es la mejor manera de evaluar y fomentar cambios en el posicionamiento, históricamente impuestos a las escuelas actuales.

Palabras clave: Ciencia-Tecnología-Sociedad-Medio Ambiente. Física. Práctica Docente.

1 INTRODUCTION

In recent decades, discussions about improving the quality of science teaching, especially physics, have gained space in the Brazilian educational field. The persistence of traditional pedagogical practices, centered on the memorization of formulas and an excessively content-based approach, has generated a distance between scientific knowledge and the reality experienced by students. In this context, the Science-Technology-Society-Environment (CTSA) approach emerges as a theoretical-methodological proposal that seeks to resignify the teaching of Science, promoting the articulation between scientific knowledge and the social, cultural, environmental and technological contexts of the subjects involved in the educational process.

The teaching of Physics, in turn, plays a fundamental role in the construction of a scientific culture capable of forming critical citizens who are aware of the implications of scientific-technological knowledge in contemporary society. By considering Physics not only as a set of abstract concepts, but as a field of knowledge deeply linked to everyday life and current social and environmental challenges, the CTSA approach provides new possibilities for pedagogical approaches that favor meaningful learning and the development of students' intellectual autonomy.

However, the effective implementation of this approach in Brazilian public schools still faces obstacles, such as the absence of teacher training focused on critical and reflective practices, curricular rigidity, lack of contextualized didactic resources, and the difficulty of breaking with historically rooted teaching models. In view of this, it is urgent to reflect on the possibilities and challenges of adopting the CTSA approach as an alternative for the renewal of Physics teaching, especially in the final years of basic education.

The main objective of this project is to investigate how the CTSA approach can contribute to making the teaching of Physics more meaningful, contextualized and socially relevant. From a theoretical and reflective analysis, it is intended to understand how this perspective can be incorporated into the pedagogical practices of teachers, contributing to the critical and civic formation of basic education students.

2 JUSTIFICATION

The teaching of Physics in basic education, traditionally guided by abstract and decontextualized approaches, has generated disinterest and learning difficulties among

students. This reality compromises not only the understanding of scientific content, but also the formation of critical and active subjects in society. Faced with a scenario increasingly marked by technological advances and the complex relationships between science, technology, society and the environment, it is essential to rethink the pedagogical practices adopted in the classroom.

The CTSA approach presents itself as a powerful alternative for overcoming these challenges. By promoting the integration between scientific knowledge and social and environmental contexts, this approach favors more meaningful learning, which values critical thinking and citizen participation. Its adoption in the teaching of Physics can contribute to making the contents more accessible, arousing the interest of students and expanding their understanding of the role of science in building a fairer and more sustainable society.

Therefore, this project is justified as an opportunity to deepen the reflection on the implementation of the CTSA approach in the teaching of Physics, especially with regard to teacher training and the possibilities of transforming pedagogical practice. By investigating this theme, it is intended to collaborate with the construction of educational proposals that break with technicist teaching and promote a more humanizing, critical scientific education committed to the reality of students.

3 GOALS

3.1 GENERAL OBJECTIVE

To investigate the contributions of the CTSA approach to the qualification of the teaching of Physics in basic education, with emphasis on the critical formation of students and the contextualization of scientific contents.

3.2 SPECIFIC OBJECTIVES

Understand the theoretical foundations that support the CTSA approach in the teaching of Science and, in particular, in the teaching of Physics;

Analyze the potential of the STSA approach to promote meaningful and contextualized learning;

To reflect on the role of continuing education of teachers in the implementation of the CTSA approach in Physics classes;

Identify the main challenges faced by teachers in adopting this approach in real school contexts;

To propose pedagogical paths and strategies that favor the integration between Physics, Society, Technology and Environment.

4 METHODOLOGY

This project will be conducted through a qualitative research, with an emphasis on bibliographic and reflective research. The qualitative approach is adequate because it seeks to understand the social, cultural and educational dimensions involved in the teaching of Physics, prioritizing the interpretation and critical analysis of educational phenomena, rather than the quantification of data.

The bibliographic research will consist of the analysis of academic productions, scientific articles, books and official documents that deal with the CTSA approach, teacher training and science teaching methodologies. Authors such as Bazzo, Auler, Santos, Mortimer, Paulo Freire, Teixeira, among others, will be used as a theoretical basis to support the proposed discussions.

In addition to the bibliographic review, the methodology will include a critical reflection on the teaching practice, based on the author's experience with the teaching of Physics in basic education and with continuing education processes. This reflection aims to articulate theory with practice, enabling a more contextualized analysis that is closer to the reality of Brazilian public schools.

The research will be developed in three main stages:

- Survey and critical reading of the literature on the CTSA approach and the teaching of Physics;
- Systematization of the main concepts and discussions relevant to the topic;
- Elaboration of proposals and pedagogical referrals that can subsidize more contextualized and critical teaching practices.

5 DEVELOPMENT

The discipline of Physics, as part of the school curriculum of basic education, whether technical or not, causes many expectations in students. Its contribution should be the formation of a scientific culture, because, through it, the student will be able to establish relationships between facts and phenomena, technologies and natural

processes.

According to the National Curriculum Parameters (PCN) (Brasil, 2000), traditional teaching could handle the demands a long time ago, a time when critical thinking was seen as an isolated privilege, and nowadays this logic has faded away.

Regarding the teaching of Physics, according to the document, the changes in school activities should not be based only on the creation of lists of new exercises or altered formats of books and updates of scientific curiosities. Far beyond that, it must create an innovative visualization for the teaching of the subject:

> Present a physics that explains the fall of bodies, the movement of the moon or stars in the sky, the rainbow and also the laser beams, the images of television and the forms of communication. A physics that explains the expenses of the 'electricity bill' or the daily consumption of fuel and also the issues related to the use of different sources of energy on a social scale, including nuclear energy, with their risks and benefits. A physics that discusses the origin of the universe and its evolution. That deals with the refrigerator or combustion engines, photoelectric cells, the radiations present in everyday life, but also the general principles that allow us to generalize all these understandings. A physics whose meaning the student can perceive at the moment he learns, and not at a time after learning. (BRASIL, 2000 p. 23)

Therefore, from this perspective, it is worth thinking about what our continuing education provides for these changes, how much we, as professionals in the field of education, more specifically teachers, working in classrooms of this basic education will be collaborating so that these principles desired and expected by the PCN are, in fact, achieved in classrooms throughout the country.

Reflection is a constant part of our work, we stop to reflect on our practices at the end of each quarter, semester or time corresponding to the teaching and result of a certain content of our discipline. At this point, by endorsing this thought, we can highlight the postulates of Bazzo and Auler (2001), when they emphasize that:

> If the process is inexorable, it excludes the possibility of changing the rhythm of things. The participation of society would in no way alter the course of the ongoing process. In this linear model, the idea of the inevitability of the process and progress is present, freeing society from participation in decisions that involve its destiny. (BAZZO and AULER, 2001, p. 10)

Because of this, to think that if society can be exempted from the responsibility of our work, it is to deny the existence of social influence on our actions, which in fact,

would be a great mistake, because what must also be recognized as a teaching task is the role of trying to make society an accessible place to all the subjects who are present in it. Through projects and actions that facilitate the approach of any individual without making any distinction between the diversities that exist in our path.

To this end, according to the ideals of Bazzo and Auler (2001), it can be stated that even though the history of issues pertinent to the teaching of physics has been engraved in the soul of a large group of teachers, the STS approach needs to be thought of as a viable alternative for a positive and significant change in the learning of physics from the final years of basic education of the subjects, to learning that can contribute to their future experiences, outside of school.

> Without postulating a historical determinism, but admitting that historical conditioning must have left marks on the thinking of Brazilian teachers, the intention of implementing the STS movement/focus in the Brazilian educational context poses questions such as: what is the understanding of science teachers about the interactions between science, technology and society? What are their beliefs, their conceptions of progress? Do teachers linearly associate progress with technological innovations, supposedly neutral? Wouldn't the historical process experienced have contributed to a significant portion of teachers endorsing a technocratic perspective, a conception that makes the STS movement unfeasible? These are issues that, in our opinion, require a theoretical and empirical deepening for an effective implementation of the STS approach in the Brazilian context. (BAZZO and AULER, 2001, p. 12)

Furthermore, thinking about the possible alternatives for movements and modifications regarding our professional practice is what permeates the actions and what keeps us active as active professionals and researchers in the area of education. What is recognized about the practice of a teacher who questions imposed and non-violable methods is that the search for answers to questions that change over time makes him continue to look for viable alternatives to develop a good work.

In this way, questioning not only the teaching practice, but also everything that is imposed on it, leads us to a path that points out more questions than answers and that makes us think beyond the postulates referenced by parameters. And, thus, the search for answers brings us different positions to which we raise our gaze and sometimes we perceive the similarity between our line of reasoning and what researchers in the area describe.

In this sense, it is important to highlight what the authors Santos and Montimer

(2002) address about issues related to teaching and some of its developments. According to them, thinking beyond the teaching of everyday life is consistent with:

> This differs from the fad of the so-called everyday teaching, which is limited to scientifically naming the different species of animals and plants, the chemicals of daily use and the physical processes involved in the operation of electrical and electronic devices. A teaching that contemplates only aspects of this nature, in our view, purely encyclopedic, favoring an almanac culture. This would be a good way to 'sweeten the pill', that is, to introduce some application just to disguise the excessive abstraction of a purely conceptual teaching by leaving, on the sidelines, the real social problems. (SANTOS and MORTIMER, 2002, p. 07)

We must recognize, as teachers, the importance of working on the teaching of physics based on questions coming from students, something that can attribute to them some purpose, some important meaning for the resolution of questions that may be experienced by them. So that, in this way, our teaching practice, in addition to making sense to us, transmits to them the credibility they need about the performance and development of our work.

Still on this line of reasoning, we highlight the reference on technological education in which the authors point out the need to go beyond issues related to limited knowledge of technical explanation about the functioning of devices. For them, these are deeper issues implied in this classroom logic and the teaching-learning relationship that is established in the school environment between teacher-student subjects.

> In this sense, we understand that technological education in high school goes far beyond the provision of limited knowledge of technical explanation of the functioning of certain technological artifacts. It is not simply a matter of preparing the citizen to know how to deal with this or that technological tool or to develop representations in the student that equip him to absorb the new technologies. Such knowledge is important, but an education that is limited to the use of new technologies and the understanding of their functioning is alienating, as it contributes to maintaining the process of domination of man by the ideals of profit at any price, not contributing to the search for sustainable development. (SANTOS and MORTIMER, 2002, p. 09)

Furthermore, it is worth emphasizing what they say about the importance of the application of science and technology:

> A study of the applications of science and technology, without exploring its social dimensions, can provide a false illusion that the student understands what

> science and technology are. This type of approach can generate a distorted view of the nature of this knowledge, as if it were entirely at the service of the good of humanity, hiding and defending, even if unintentionally, the economic interests of those who wish to maintain the status quo. (SANTOS and MORTIMER, 2002, p. 12)

Another aspect that we consider relevant about the concepts listed by these authors in the search for answers to the questions related to the implementation of STS, focuses on the social role of Physics.

> It is no use just inserting social themes in the curriculum, without any significant change in practice and pedagogical conceptions. It is not enough for textbook publishers to include social themes in their books, or to disseminate the so-called paradidactics. Without an understanding of the social role of science teaching, we can make the mistake of simply making up current curricula with hints of applying science to society. In other words, without contextualizing the current situation of the Brazilian educational system, the working conditions and teacher training, it will be difficult to contextualize scientific content from the perspective of citizenship formation. (SANTOS and MORTIMER, 2002, p. 18)

Of the legacies left for our use, we can highlight as the core of our teaching understanding, the works offered by Paulo Freire, which makes our task of sharing knowledge even more valuable, if we understand the transformative role of education in society as a whole. To this end, contributions such as those of Zaiuth and Hayashi (2011) pose some questions to be thought about. Among them, the following deserve to be highlighted:

> Paulo Freire's proposal requires the participation of an interdisciplinary team. In order to have interdisciplinarity in scientific and technological education, it is necessary to present a counterpoint to the official views present in the education systems and to build a source of alternative views, a fact that should be present in the continuing education of teachers. Freire's proposals and STS approaches require a new type of education professional, who is part of the dialogical conception of education. (ZAIUTH and HAYASHI, 2001, p. 282)

Furthermore, what is expected of a teacher who has been able to learn about Paulo Freire's legacy goes far beyond what textbooks can offer, believing in the social transformation of the subject through education implies questioning much of what is imposed and trying to seek new answers, as stated by Santos (2008):

> His proposal is a new form of educational praxis, which instead of reproducing the world will transform it. The generative words, full of meaning for the students, are instruments for rethinking the world. In this sense, his proposal is an education for awareness, which goes beyond the act of teaching reading and writing. The student would use reading and writing to trigger a social process of transformation of his reality. (SANTOS, 2008, p. 116)

The STS movement emerged in the context of first world countries, which ended up limiting it to the borders of those places. The central issues debated in the curricular proposals with emphasis on STS in this movement focused on technological impacts on society and, beyond them, on their consequences in relation to the environment, which is why many of them adopted the acronym CTSA, which adds the environment as another focus of analysis in the interrelations of the STS triad. (Santos, 2008)

Because of this emergence in countries that had a much higher economic and social issue, when compared to Brazil, it can be said that this approach was seen with a certain disregard when presented to national research, which makes it even more difficult to apply it in all spheres of education available in the country. The possibility of bringing together science, technology and society can be avoided by a portion of the population that sees as an obstacle any alternative that proves to be viable to the traditional teaching of content. According to Santos (2008):

> While the STS movement was initially defended by left-wing educators, it seems to us that at that time somehow its purposes often incorporated the political dimension considered by Freire in search of the ideal of justice and social equality. The focus in this sense of questioning dominant values reproduced in teaching in science teaching has been defended not only by authors linked to the STS movement, but also in works not always identified as STS. (SANTOS, 2008, p. 118)

Another perspective that deserves to be highlighted is the STS approach under the analysis of Teixeira (2003), when he emphasizes that according to scientific evolution in the light of this approach, the historical-critical pedagogical current of knowledge can collaborate with the understanding of its need in school bases. For the author:

> With this, we seek to show that these pedagogical currents can influence the pedagogical practice exercised in the teaching-learning of sciences. We need to change the reality of classes that cultivate abstract and fragmentary knowledge, incapable of dealing with the problems experienced in society. We need to invest

> in teacher training, initial and continuous, taking as a standard the teachers we have today. And from this reality, we can build a new profile of educators, who have a broader view of the role of the school in society, as a real instrument to convert subjects into citizens, and to build a new reality: just, humane and democratic. (TEIXEIRA, 2003, p. 188)

These authors help us to glimpse our research perspective, at the heart of its main objective, which is to find new alternatives to develop a quality work that has a consistent meaning for our student. From his reflections on the subject addressed, we can see beyond the theory what we should start thinking about to plan our next actions in relation to the STS focus at all levels of education, but especially in the years of basic education, which are the means of our activity.

In addition to his reflections, we seek to understand and interpret his postulates in order to ensure a practice based on theoretical currents that identify our posture as a research teacher, which is unsettling and uncomfortable, pulls us out of the comfort zone so that we can base our thinking on something already published. In this sense, according to Junior (2014) et al.:

> It is important to highlight that, although they are *exchangeable* with each other for certain values, as *useful* goods, commodities cannot be reduced to each other. That is, with regard to the human need that is satisfied, a bed cannot be reduced to a coat; in a chair to a table. Consequently, the value at which a commodity is accepted to be exchanged cannot be strictly deduced from its useful qualities. For example, a necklace of gold and diamonds is not more expensive than a wooden chair because it is more useful! Thus, there must be some material characteristic common to all commodities that allows us to define (even approximately) the values at which these commodities are exchangeable. (JUNIOR et. al. 2014, p. 178)

In addition, the author points out that the examples of scientific innovations are as varied as possible, and that there are countless examples that have served to increase efficiency in various branches of production, and, therefore, to produce relative surplus value. Although several of these innovations have their positive aspects highlighted insistently in the media, their potential to wear down the conditions of the existence of the working class is little or not at all relevant in discussions about science education. (JUNIOR et al.:2014)

Like the internet, as a current of technological innovation, it has intensified and cheapened the exchange of information from companies of all kinds, minimizing the time

needed to produce goods and provide services, which facilitates communication between suppliers, producers and customers, and frees workers involved in bureaucratic communication processes. (JUNIOR et al.: 2014).

To make the concept of surplus value clearer, which explains why we adopted it in some moments of our discussion, we can bring the concept explained by Junior et al.: (2014), to the authors:

> The concept of relative surplus value is, in Marx's theory of value, the most instrumental for analyzing the relations between S&T, capital and the working class. However, in order to truly understand this concept, it was necessary to return to some fundamental definitions and arguments of the Marxian reference (such as the concepts of commodity, value and capital). The resumption of these fundamental concepts allows us to realize that the real engine of capitalist society is the greedy desire to exchange money for more money, and that, therefore, scientific and technological innovations tend to be employed on a large scale only to the extent that they represent more economically profitable alternatives for the capitalist. (JUNIOR, Et. Al.: 2014, p. 192)

What is sought with respect to all the concepts established by these authors is the ability for the CTSA approach to guide teaching actions without being seen as something that can raise doubts at the time of its explanation and application in classroom practices. From this maeira, according to the authors Silva and Araújo, it can be said that:

> Science and technology are gaining more and more relevance, as well as their teaching, with economic, social and environmental implications, becoming a crucial issue in education. In this sense, the integration between the STS and T&E fields, especially with regard to the assumptions of EFA, expands the possibilities of the curriculum. It allows the discussion of the real objectives of science and technology teaching beyond economic determinations. (SILVA and ARAÚJO, 2012, p. 110)

In addition to these statements and directing the reflection to the final considerations, we can also emphasize the importance of aligning the scientific knowledge presented in the school benches with the scientific knowledge produced by the academy, or at least, exploring the possibilities of being able to align them. According to the authors Oliveira, Carvalho and Almeida (2021) it is stated that:

> The scientific knowledge produced by the academy is different from the scientific knowledge presented in the school, as it has different commitments. In turn, it is also different from the knowledge transmitted to the people. In addition to the existence of a natural hereditary relationship with science, there is a relationship of affiliation between school science and popular science. It certainly loses the characteristics that had already been abandoned by school science and more about the production by collective structuring produced by a community of specialists. (OLIVEIRA, CARVALHO and ALMEIDA, 2021, p. 51)

Therefore, after these theoretical assumptions in relation to the STS approach and its application in the grades of basic education, we can affirm that most of them express a clarity and coherence regarding the importance of the discipline of physics being allied to the focus both in the planning of its curriculum and in the core of its teaching actions.

After all the notes, we leave a reflection: when a trajectory to be carried out by the school goes through dialogue and the acceptance of good ideas, considering the participation of all subjects involved in the teaching-learning process, there is a better perspective that it will be implemented and successful.

To this end, this process, in addition to providing the collective construction of solutions applicable to each situation, aiming at actions planned by people close to them and who have clear knowledge of the problems, also allows the authors involved to be a significant part and not have the feeling of being mere executors of activities elaborated by others.

6 FINAL THOUGHTS

From the theoretical discussions presented throughout this article, it becomes evident that the STS/CTSA approach represents a powerful and necessary pedagogical proposal for the renewal of the teaching of Physics in basic education. This approach, by articulating science, technology, society and the environment, expands the possibilities of understanding scientific content, overcoming the purely technical and encyclopedic logic, still so present in school practices.

The debate about the social role of science, driven by authors such as Bazzo, Auler, Santos, Mortimer and Freire, points to the urgency of an education that forms critical subjects, aware and capable of intervening in the reality in which they live. Physics, in this sense, should cease to be seen as an isolated set of formulas and definitions, and start to be understood as contextualized, relevant knowledge connected to the needs and

challenges of contemporary society.

The continuing education of teachers, discussed throughout the text, appears as a key element for the effective implementation of this approach. It is through it that teachers can resignify their practices, abandon traditional teaching centered only on the transmission of content and, based on research and reflection, plan more meaningful and transformative educational experiences.

Facing the structural, ideological and formative difficulties that still limit the application of the CTS/CTSA in Brazilian schools requires collective commitment and consistent public policies. However, even in the face of obstacles, it is possible — and necessary — to initiate movements of change based on daily practice, through active listening to students, valuing their questions and inserting themes relevant to their social experience.

Thus, the STS/CTSA approach should not be seen as a passing trend or as an appendix to the school curriculum, but as a theoretical-methodological perspective that enables the construction of a critical scientific education, contextualized and committed to citizenship education. It is up to us, teachers and researchers, to assume the role of agents of this transformation, aware that each pedagogical practice can indeed be a political and emancipatory act.

REFERENCES

Araújo, A., & Silva, M. A. (2012). Ciência, tecnologia e sociedade; trabalho e educação: Possibilidades de integração no currículo da educação profissional tecnológica. Ensaio: Avaliação e Políticas Públicas em Educação, 20(76), 545–566. https://doi.org/10.1590/S0104-40362012000300008

Auler, D., & Bazzo, W. A. (2001). Reflexões para a implementação do movimento CTS no contexto educacional brasileiro. Ciência & Educação, 7(2), 261–276. https://doi.org/10.1590/S1516-73132001000200007

Brasil, Secretaria da Educação Média e Tecnologia, Ministério da Educação. (2000). Parâmetros curriculares nacionais: Ensino médio – Parte III – Ciências da natureza, matemática e suas tecnologias. Brasília, Brazil: Ministério da Educação. Retrieved August 2025, from http://portal.mec.gov.br/seb/arquivos/pdf/ciencian.pdf

Junior, P. L., Deconto, D. C. S., Neto, R. A., Cavalcanti, C. J. H., & Ostermann, F. (2014). Marx como referencial para análise de relações entre ciência, tecnologia e sociedade. Ciência & Educação, 20(2), 301–316. https://doi.org/10.1590/1516-73132014000200004

Oliveira, M., Carvalho, A. S., & Almeida, M. M. N. (Eds.). (2021). Educação científica e popularização das ciências: Práticas multirreferenciais (Vol. II). Curitiba, Brazil: Appris. Retrieved December 2021, from https://www.editoraappris.com.br/produto/4828-educacao-cientifica-e-popularizacao-das-ciencias-praticas-multirreferenciais

Santos, W. L. P. (2008). Educação científica humanística em uma perspectiva Freireana: Resgatando a função do ensino de CTS. Alexandria: Revista de Educação em Ciência e Tecnologia, 1(1), 109–131. Retrieved June 2025, from https://periodicos.ufsc.br/index.php/alexandria/article/view/37426

Santos, W. L. P., & Mortimer, E. F. (2002). Uma análise de pressupostos teóricos da abordagem C-T-S (Ciência – Tecnologia – Sociedade) no contexto da educação brasileira. Ensaio: Avaliação e Políticas Públicas em Educação, 10(34), 7–24. https://doi.org/10.1590/S0104-40362002000100002

Teixeira, P. M. (n.d.). A educação científica sob a perspectiva da pedagogia histórico-crítica e do movimento CTS no ensino de ciências. Ciência & Educação. Advance online publication. https://doi.org/10.1590/1516-73132014000100006

Zaiuth, G., & Hayashi, M. C. (2011). A apropriação do referencial teórico de Paulo Freire nos estudos sobre educação CTS. Revista Brasileira de Ensino de Ciência e Tecnologia, 4(3), 1–15. Retrieved December 2024, from https://www.revistabrasileiradects.ufscar.br/index.php/cts/article/view/129