ACTA SCIENTIAE

ISSN: 2178-7727
DOI: 10.17648/acta.scientiae.4709

Educational Practices in Science-Technology-Society and the Social Participation in the Scientific-Technological Development

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Received for publication on 21 Set. 2018. Accepted, after revision, on 13 Nov. 2018.
Assigned editor: Renato P. dos Santos.

ABSTRACT

The STS movement, which emerged in embryonic state in the middle of last century and made itself over the decades, remains relevant to the society we live in. Thus, it is recurrent the need for a participation of this society in the direction given to the scientific and technological activity, demanding more democratic decisions. In this sense, this research is based on the questionings, what is the characterization of educational practices carried out in STS Field in Basic Education and in teacher training, and how has been the participation of society in scientific and technological development? As objectives, we seek: (i) identify which and how subjects have participated in decision-making on scientific and technological development; (ii) analyse data referrals in respect of educational practices STS; (iii) to investigate whether the STS assumptions are advancing the Academy to implement educational practices; (iv) to point out horizons for Science Education in the perspective of curricular settings guided by the constitution of a culture of participation. It is a bibliographical research whose methodology was the Discursive Textual Analysis, composed of unitarization, categorization and communication. From the corpus of analysis emerged four categories: 1) *Limitations practices STS implemented*; 2) *Methodological aspects of STS practices*; 3) *Social participation in the development of ST in classrooms*; 4) *Justifications for insertion of STS practices*.

Keywords: STS movement. Social participation. Educational practices. Scientific and technological development.

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Práticas Educativas em Ciência-Tecnologia-Sociedade e a Participação Social no Desenvolvimento Científico-Tecnológico

RESUMO

O movimento Ciência-Tecnologia-Sociedade, que surgiu embrionariamente em meados do século passado e tem se constituído ao longo das décadas, permanece relevante à sociedade na qual vivemos. Assim, é recorrente a necessidade de uma participação dessa sociedade no direcionamento dado à atividade científico-tecnológica, reivindicando decisões mais democráticas. Nesse sentido, a investigação é baseada nos questionamentos: qual a caracterização de práticas educativas realizadas no campo CTS na Educação Básica e na formação de professores?; E, como tem sido a participação da sociedade no desenvolvimento científico-tecnológico? Como objetivos, buscamos: (i) identificar quais sujeitos têm participado na tomada de decisões sobre o desenvolvimento científico-tecnológico, e de que forma (ii); analisar encaminhamentos dados, relativamente às práticas educativas CTS; (iii) investigar se os pressupostos CTS estão avançando na Academia para práticas educativas implementadas; (iv) sinalizar horizontes para a Educação em Ciências na perspectiva de configurações curriculares pautadas pela constituição de uma cultura de participação. Trata-se de uma pesquisa de cunho bibliográfico, cuja metodologia utilizada foi a Análise Textual Discursiva, composta pela unitarização, categorização e comunicação. Da análise do *corpus* constituído dos Anais do Encontro de Pesquisas em Ensino de Física e das edições do periódico Experiências em Ensino de Ciências, emergiram quatro categorias: *1) Limitações de Práticas CTS implementadas; 2) Aspectos metodológicos de práticas CTS; 3) Participação social no desenvolvimento da CT nas salas de aula; 4) Justificativas para a inserção de práticas CTS.*

Palavras-chave: Movimento CTS. Participação social. Práticas educativas. Desenvolvimento Científico-tecnológico.

INTRODUCTION

STS Movement and the Brazilian Educational Context: Contextualizing the Investigation Problem

We are currently experiencing a growing and exponential evolution in our society, especially in relation to Science-Technology (ST), sometimes affecting the Environment and Education. Faced with this process of evolution, the main link between scientific-technological development and social participation in the direction of this development is centred in the school environment, that is, in Basic Education (BE) and in teacher education. In this context, in the last decades the need to question with society the problems and limitations of scientific and technological activity and its repercussions on society and the environment, in which a greater participation of the subjects in the decisions is required (Strieder & Kawamura, 2007).

The origin of the Science-Technology-Society (STS)[1] movement, according to García, Cerezo and Lopez (1996) is focused on the mid-twentieth century, as a response to the dissatisfaction with the traditional conception of ST, as well as the political and economic problems environmental degradation and scientific and technological

[1] Refers to the repercussions of the STS movement in general and social scope.

development. This arises, with the feeling of dissatisfaction that scientific-technological and economic development were not "conducting linearly and automatically to the development of social welfare" (Auler, 2011, p.75).

Thus, the research problem that guided this construct was based on the problematic: How has the participation of society in scientific-technological development been consolidated by analysing the characterization of educational practices carried out in the STS Field in Basic Education and in teacher training?

As objectives, we seek: (i) to identify how social participation and the problematization of decision-making in the given scientific and technological development are presented; (ii) analyse data referrals regarding STS educational practices; (iii) investigate whether STS assumptions are moving from academia to implemented educational practices; (iv) to point out horizons for Science Education in the perspective of curricular settings guided by the constitution of a culture of participation.

In terms of research, this is a qualitative bibliographic research, resulting from a Course Completion Work, next to one of the Physics-Graduation Courses of the *Universidade Federal da Fronteira Sul*. In which, from the productions that appear in the Annals of the *Encontro de Pesquisa em Ensino de Física (EPEF)* and the electronic journal *Experiências em Ensino de Ciências (EENCI)* considered representative in the scope of Science Education in Brazil, we seek to investigate and signal the characterization of STS educational practices.

STS movement: Genesis, Trajectories and Contributions

Although it emerged in the middle of the last century, and was constituted over the decades, the assumptions of the STS movement remain relevant to the society in which we live. The need for a participation and reflection of the society in the direction given to the scientific-technological activity is recurrent.

In relation to the curricular horizon with emphasis STS, Auler and Delizoicov (2001), they classify the curricula in two visions: the reductionist and the enlarged one. The reductionist view is marked by the emphasis on the conception of ST neutrality in order to contribute to the consolidation of the myths of the superiority of the technocratic decision model, the Salvationist perspective linked to ST, and technological determinism. In turn, the expanded view seeks to understand the interactions between STS from the perspective of criticizing the current model of economic development (Auler & Delizoicov, 2001), as well as overcoming ST neutrality and problematizing myths.[2]

[2] It refers to the myths of the superiority of the model of technocratic decisions, of the Salvationist perspective linked to ST, and of technological determinism. The supposed superiority, neutrality of the model of technocratic decisions, starts from the premise of neutralization of the subject in the scientific-technological process; the Salvationist perspective of ST refers to the ST as the savior of contemporary problems, which is conducive to social welfare; technological determinism, according to Auler (2002), refers to technological changes as the cause of social changes, being technology, autonomous of social influences.

Thus, its origin has been associated, among other aspects, with overcoming the conception of ST neutrality, and with demanding decisions that are more democratic. Faced with this democracy, Cachapuz (2011) defends participatory democracy and not only representative democracy, as a regulatory axis between the ST and power. Thus, the STS triad is more than a simple composition of these three concepts. It is a repercussion that emphasizes the existence of important links between them, whether in BE or in initial and continuing teacher education.

In the face of all this advancement of ST, Varsavsky (1976) states that we often tend to think about ST's progress and development, exclusively in quantity rather than content when we reflect on scientific development. However, we cannot let ourselves be overshadowed by this amount of scientific-technological products present in our society. It is necessary to evaluate the expenses, the satisfactions of the basic necessities of the entire population as well as their methods and relations of production. Implicating to analyse the possible and different trajectories of development of this product/content in the educational scope, that is, of the BE the teacher training.

Thus, the repercussion of the STS movement in the educational field has been associated, among other aspects, with overcoming the conception of ST neutrality. According to Aikenhead (2003), the STS movement manifested itself in the late 1970s and early 1980s, at a time when there was a broad consensus among science educators about the need for area. Realizing, in multidisciplinary approaches, with curricula organized around themes, real problems, repercussions in the search for democratization of decision-making processes (Auler, 2007; García, Cerezo & Lopez, 1996). Although in the contemporary epistemological reflection the concept of neutrality has been overcome, many analyses present in society and also in Education in Sciences corroborate this view.

Correlating with STS repercussions to curricula, Santos (2008) states that a problem-based education involving the STS triad must seek to incorporate into the curriculum discussions of values and critical reflections aimed at unveiling the human condition. However, it is not an education against the use of ST or an education for use, but an education in which students can reflect on their condition in the world in the face of the challenges posed by this ST.

In this sense, Santos (2012) affirms that there are many analyses still present in the Academy and in the Scientific Education of the BE that are coherent with the conception of the neutrality of the ST. However, in previous work (Polanczky, Karas & Santos, 2015) we observe that many practices implemented in BE have a certain limitation in the STS articulation, sometimes defining a STS practice, such as the insertion of a daily fact, but without bringing the reflection and democratic participation on factors allied with the triad.

In which, theoretically and academically, the relevance of problematizing the agenda, use and post-use of ST products is presented, many educational practices end up prioritizing theoretical and scientific concepts, leaving aside the environment, economy, politics , that is, its surroundings. Of this, the need to return to the discussions on the emancipation of man in the face of scientific-technological development, as well as the

environmental question. This is an ever-present concern throughout society and it is a reality in which we need to look for possible solutions.

In this sense, Polanczky, Marmitt and Santos (2015) affirm that the articulation of concepts with real experiences/problems of the students in the classroom, potentiate the re-signification and the awareness of values, attitudes and factors, sometimes implicit in the textbook as well as in the teacher's speech.

Thus, through the analysis of the productions of the *corpus* of this research, we propose to signal STS approaches in BE and teacher training. In addition, to investigate the characteristics, methodologies and participation of society (set of subjects involved in the developed practices), seeking to evaluate possible advances of STS assumptions present in the Academy for the classroom.

METHODOLOGICAL REFERRAL

This work consists of a qualitative bibliographic research, that is, a documentary analysis, which "can be a valuable technique to approach qualitative data, either complementing the information obtained by other techniques, or revealing aspects new ones of a theme or problem" (Lüdke & André, 1986, p.38). For this documentary analysis, we follow the methodology according to Moraes (2003), where we deepen the understandings of the phenomena investigated from a rigorous and careful analysis of the information obtained and do not test hypotheses to be proven or refuted.

The methodological dynamics followed according to the Discursive Textual Analysis (DTA) (Moraes, 2003; Moraes & Galiazzi, 2006; Moraes & Galiazzi, 2007), according to Moraes (2003), from a set of texts, a new text describing and interpreting meanings and meanings of these initial texts.

Thus, DTA:

> [...] can be understood as a self-organized process of understanding construction in which new understandings emerge from a recursive sequence of three components: **deconstruction of *corpus* texts, unitarization; establishing relationships between unit elements, categorization; the capture of the new emerging in which the new understanding is communicated** and validated. (Moraes, 2003, p.192) [Our emphasis]

It always starts from the premise of reading as an interpretation, and it does not consolidate in a single and objective way, because, regardless of similar interpretations in the same group, "a text always makes it possible to construct multiple meanings" (Moraes & Galiazzi, p.14). In addition, this multiplicity of meanings originates from the theoretical presuppositions adopted by the reader. It is "[...] impossible to see without theory; it is impossible to read and interpret without it" (Moraes & Galiazzi, 2014, p.15).

Unitarization consists of the disassembly of the original texts, units in which the analyst will attribute "senses and meanings" (Moraes, 2003, p.192). The signifiers are the original texts themselves, or the corpus of analysis, from which the analyst extracts his units and attributes meanings and meanings in the face of his theoretical perspectives and the objectives of the research. Categorization consists in "bringing together similar elements [...] naming and defining categories" (p.197). "The third stage consists of capturing the new emergent, in which the understandings and theorizations reached in relation to the studied phenomena will be expressed and validated" (p.202).

For the development of this research was carried out a survey of STS research presented in the productions of the EPEF and of Electronic Journal EENCI. The corpus of analysis consists of the selection of 72 articles present in the Annals of the nine editions of the Meeting in the period of 2000-2016 and of the journal, in the period 2006-2018, Vol.1. Composing the selection, from the journal's corpus an article from 2006, one from 2009, five from 2010, two from 2011, one from 2013, two from 2014, four from 2016, five from 2017 and one from 2018; and the corpus of the event one of 2000, one of 2002, three of 2004, eight of 2006, eleven of 2008, six of 2010, one of 2011, ten of 2012, three of 2014 and six of 2016.

In this definition of the corpus of analysis, self-identified articles were selected in the title, abstract, keywords and/or when necessary, in the introduction, the words STS and STSE (Science-Technology-Society-Environment) and the identification of work related to the practices implemented in the classroom in BE, as well as, practices involving the articulation between researchers, teachers in initial formation (TIF), continued and students in the educational spaces.

ANALYSIS, DISCUSSIONS AND POSSIBILITIES

Faced with the delimitation of the research corpus, we noticed that the STS practices implemented in both Basic Education and TIF and Continued Teacher Training (CTT) are timid and limited but significant over the years. Expressions that have repercussions in Education in Sciences once we perceive the involvement and the development of STS practices in the Brazilian educational context.

Regarding EENCI journal, we realized that all STS practices were implemented both in BE and in initial teacher training, however, it reflects the absence of articulation of STS assumptions in continuing education and that sometimes has repercussions in the classroom. Through the analysis, with reference in the DTA, we perceive the emergence of a set Initial Formation of justifications and referrals related to non-neutrality of the ST in the curricular perspective and in the production of knowledge.

For this, we highlight the emergence of four categories: 1) Limitations of STS Practices implemented; 2) Methodological aspects of STS practices; 3) Social participation in the development of ST in classrooms; 4) Justifications for the insertion of STS practices. We prioritize these categories, as they characterize STS practices as to the justifications,

methodologies and limitations/challenges present in them, both in BE and in TIF and CTT, belonging to the EPEF Annals and the EENCI editions.

Limitations of Implemented STS Practices

According to Santos and Mortimer (2001), when we propose an education with the STS presuppositions, "we need to go beyond conceptual teaching towards an education focused on responsible social action, where there is concern about the formation of attitudes and values" (p.107). However, this is not an easy task considering the variety of problems and difficulties faced by teachers, especially BE. Thus, in this category, we bring some of the limitations and obstacles perceived by teachers and researchers by promoting in their practices the STS approach.

Through the analysis we realized that the limit of time and space to work with STS proposals are limiting factors, there is no availability of hours for planning as highlighted in an article that sought the application of the STS Approach in Biology classes, concept of Genetics. The class teacher comments on "[...] the limited time available for Biology classes in High School, a fact that is seen by the educator as the main obstacle to the applicability of the STS Approaches" (Sousa & Teixeira, 2010, p.97). In addition, it shows that in the school context itself there is "[...] the need to comply with the standardized program [...] the fragmented teaching by disciplines has become an obstacle to the development of a STS education and a broader work involving all the school and the various areas of knowledge" (Sousa & Teixeira, 2010, p.100).

Among other problems for the contextualization of the STS approach, we also have the fact that

> [...] the majority of Brazilian teachers, because they receive low salaries, are forced to work excessively, even filling workloads close to 60 hours a week, which prevents them, or at least hampers them, from attending training courses, studying and getting involved in more careful planning of your classes. (Sousa & Teixeira, 2010, p.99-100)

Considering these first embarrassments faced in the school context, we believe that we need to develop policies publics and a restructuring of the school curriculum, as well as providing adequate remuneration with more flexible planning formulation. Aside from this, it is important to invest in a higher initial education, as well as in continuing education, denoted with tools, methodologies and practices that allow bringing this approach in the school context. Once

> […] studies have shown that teachers do not know much about the STS approach, highlighting the need for specific training in this field, that is, the need for STS

> subjects to be included in initial and continuing teacher training, so that they can contribute more adequately to improve and to innovate the teaching of the sciences, aiming to achieve a scientific and technological literacy more adjusted to their needs. (Pinheiro, Silveira & Bazzo, 2007, p.81)

Another limiting point is the reductionist view, where we can observe the prevalence of the supposed neutrality of the ST, related to the curricular configurations. This is evident when the researcher affirms that students in a general way have the "impression that such problems do not reach them as if they lived in a world apart" (Souza & Medeiros, 2010, p.3). Referring to the idea that problems are destined to adults, to something future, that does not demand participation and concern of them. In this sense, Roso (2012) states that "To obtain information that is so complex and diverse, only in the future to participate in decision-making on issues involving ST is something unthinkable" (p.186).

Another example of a reductionist view is presented in the report of a practice developed with students of the 2nd year of Polytechnic High School. Through the same one was tried to evaluate the relations STS established by the involved ones, thus the proposal was based on the discussion related to the subject energy, through texts written by the own students. Thus, the author cites a student's speech in correlating science and technology; "Both relate to each other, bring a better quality of life to people, are linked to improve our daily life, as in the assembly of cell phones, computers [...]" (Student E) (Pansera & Netto, 2016, p.5).

We perceive through speech that there is an erroneous view of scientific-technological products, in which most of these have only positive points. That is, that everything is good and have only beneficial impacts and social benefits, in addition to neglecting social impacts. In this same vision, another article presents the vision of a student after working with the STSE approach:

> From the activities carried out in the interventions, we acquire extra knowledge about science, which is present in everyday life, and is fundamental for the knowledge of life. Science is made up of innumerable parts that over time can make a great impact being it evil or beneficial. We perceive their need for social development in areas other than human complexity. (Student 41) (Linhares, Alves, Pinto, Maria, & Bueno, 2014, p.5)

Through both sense nucleus and supported in Auler (2011) we emphasize that, in many STS referrals, there is a strong tendency to focus the impacts of the post-production of the ST, discussing the harms and benefit of the technological artefacts, but for once, there is little regard for the research agenda.

Auler (2011) and Santos (2016) point out that, in many STS referrals, there is a strong tendency to focus on the impacts of ST post-production on society. However, this instigates us to reflect on this problem, since limiting the evaluation of only the post-

production impacts means keeping them untouchable, beyond the reach of a critical analysis, reflecting, in our opinion, a limited vision of ST signalized in educational practices. In this sense, we agree with Rosa and Auler (2016) when mentioning that:

> Problematizing limited participation to post-production does not mean that it should not take place. On the contrary, we need to have access to and pay attention to impacts from the TC. However, we believe that being restricted to this type of participation means endorsing the idea that society's only objective is to receive the "ready" scientific and technological product and to make the best use of it in order to reduce negative social and environmental impacts. (p.214)

Thus, it is important to emphasize the need to encourage participation in decision-making, not limited to post-use, but also in the definition of the research agenda (pre-production).

Finally, propaedeutic teaching is seen as a limiting factor for the problematization of STS ideals. This is due to the low involvement of the teachers, since they do not have an initial formation that contemplates the various aspects of this approach, so as to transform their classes into pleasant, diversified and motivating contexts of learning (Fontes & Cardoso, 2006). This example, when a licensee says that it is a recurring student during high school: pass the entrance exam. That is, a propaedeutic education, which aims solely at the *Exame Nacional do Ensino Médio (ENEM)* or *vestibular*, without the contextualization and approximation of the school contents with those of the student's own school experience. The same student still reflects "[...] Teaching Physics only from equations and not having a contextualization [...] but for me this is difficult! I have difficulties with this" (Silva & Carvalho, 2009, p.8).

Thus, we see in the comments of the student the need to evolve with our curriculum in our TIF to promote practices and the adoption of teaching methodologies aimed at working this educational demand. Confirming the difficulty of working through the STS approach, a contextualized and critical approach, Sousa and Teixeira (2014):

> [...] the role of the teacher should undergo significant changes as teachers are required to play the role of mediators rather than the traditional role of transmitters of information. We understand that this change in the teacher's position is also characterized as an obstacle to STS education, since the training provided by teacher training courses does not always sufficiently meet this need. (p.100)

Therefore, we believe that breaking the vision of propaedeutic education aimed at the transmission of knowledge is the first step to break the limitations imposed by working the STS approach in our BE and Higher. According to Freire (2005), the revolution only occurs through the reflection and continuous dialogue of the subjects, in the perspective of

overcoming the model of banking teaching, in which the teacher deposits the knowledge of the students.

Methodological Strategies of STS Practices

The variation of practices and methodologies in the implementation of STS practices is varied, including didactic sequences, conceptual and thematic approaches, and controversial themes. In general, the problems involved from health, noise pollution, TV, nuclear power plant, astronomy, electric power, among others.

Souza and Medeiros point out "information that would be presented in final form in a simulated public hearing and **afterwards a simulated class plebiscite in which each student voted for or against thermonuclear plants**" (2010, p.6, our emphasis). They verified the methodological relevance of this practice, since it strengthens the discussions regarding the manifestations and values resulting from the implementation of thermonuclear plants of each subject involved.

We noticed, however, that many referrals were based only on the use, that is, the use of computer labs in classrooms. Machado and Nardi consider technology as one of the factors that empower teachers, stating, "It is relevant to consider the **incorporation of technologies that allow improving the teaching and learning process**" (2006, p.1, Griffin our). Contribution, Silva, Cavalcante and Ostermann propose a website for high school students, with the purpose of "teaching physics through **technological devices**" (2012, p.5, our emphasis).

Also regarding the findings on the use of scientific-technological products Dworakowski, Marranghello and Dorneles (2010) affirm that students, during the developed practice

> They observed that they can **use different forms of technology**, including those developed by them, **to solve social problems and feel that their participation as citizens**, their attitudes and opinions can and should intervene in the paths followed by society. (p.160, our emphasis)

Auler and Delizoicov (2001) referring to the ST as a redeemer of the salvation of contemporary problems, capable of leading to social welfare. We realize that although students reflect on the relevance of their interventions related to ST, they still corroborate with the reductionist view, in which technologies they are still redeeming the salvation of social problems.

We endorse that we are not against scientific-technological advances and the use of ST, but we consider how these advances are treated who decides what use is possible. After all, what science and what technology do we want? Do we have enough to solve contemporary problems? Questions that, in our view, require further study.

We defend approaches that involve these discussions and the participation of all the subjects involved in STS practices, as we can observe in the production in which "**it was sought to investigate the process of collective construction of didactic strategies to approach the subject considered**" (Bernardo, Vianna & Fontoura, 2008, p.2, our emphasis)**.** The course was divided between moments of lectures on energy, development and environment, and on the STS approach, and action-research workshops, where subjects had the opportunity to discuss and elaborate the strategies identified by the group as the most appropriate for the classroom, considering scientific-technological, political, economic, social and environmental aspects, often forgotten in the Brazilian educational context.

Social Participation in the Development of ST in the Educational Context

In this category, the validation of the studied bias, brings social participation as a necessity to change attitude towards the STS approach, referring critical education as a necessity in the educational landscape to restructure and discuss the role of the research agenda, contributing to overcome the not neutrality of the science in search of an action of all social actors before the evaluations of the impacts of the ST (Auler, 2002; Dagnino, 2014). However, Santos and Mortimer (2001) believe that

> It is not enough to provide up-to-date information on science and technology issues so that students do engage actively in social issues. How to lick is not enough to teach the student steps for a decision-making. [...] If we want to prepare students to participate actively in the decisions of society, we need to go beyond conceptual teaching towards an education focused on responsible social action, in which there is concern about the formation of attitudes and values. (p.107)

That is, it is necessary to stimulate the students so that they become social and questioning subjects, maximizing their multiple capacities, not only in the school but also in the context to which they are inserted. Therefore, Araújo and Formenton present an understanding of the need to:

> [...] develop students' critical and reflective thinking, making them understand that Science and Technology (S&T) are not activities isolated from society and the environment, both of which generate positive and negative consequences for people's daily lives social participation on their referrals. (2016, p.2)

Scientific information on topics of social relevance is indispensable, but it is not sufficient by itself. The scientific-technological literacy that we desire through the STS approach is one that generates in students changes in individual attitudes. For that, it is

essential that teachers change their postures in the classroom, incorporating social themes that cover environmental, cultural, economic, political and ethical aspects (Santos & Mortimer, 2001). For this purpose, a reported practice justifies the same considering it as a teaching sequence whose objectives:

> [...] **Were to teach contents** of thermodynamics by means of approximations with themes related to students' lives and to develop in students a culture of participation in the debate of issues related to the improvement of the quality of **life and to a sustainable society**. (Moreira, Araújo & Melk, 2012, p.2, our emphasis)

Still, seeking to work the STS approach, however in another teaching modality, an article presents the vision of a TIF in Physics that, knowing the bias, understands that: "It (Physics) can also help in the formation of a participant human being of the society, a conscious person about what is happening, participatory in the environment to which it coexists and the problems that we experience every day (Student 31)" (Paiva & Araujo, 2016, p.4). Complementing the view of the student, we believe that integral and transdisciplinary education, in addition to physics itself, can enhance social participation,

> […] we must overcome the old idea that discussing science is a task of the disciplines of chemistry, physics or biology: we share a common social commitment. All knowledge contributes equally to the task of striving for a fairer, more humane world. Thus, working within a given discipline, using the STS approach, implies enabling the learner to participate in the democratic decision-making process, promoting citizen action aimed at solving problems related to the society in which he is inserted. (Pinheiro, Silveira & Bazzo, 2007, p.82)

Thus, we believe that through integral education implemented in different realities and social contexts, we will be able to transform and democratize the number of agents involved in the ST targeting process and in the definition of the research agenda itself, overcoming the ST myths (Auler, 2002; Santos, 2012; Santos, 2016). In this sense, we agree with França et al., in believing that:

> [...] therefore, citizens in science and technology is now a necessity of the contemporary world. It is not a question of showing the wonders of science, as the media already do, but of making available the representations that allow the citizen to act, to make decisions and to understand what is at stake in the specialists' discourse. This has been the main proposition of curricula with emphasis in Science, Technology and Society (STS). (2016, p.4)

Justifications for the Insertion of STS Practices

Teaching based on the STS approach should be understood as a "possibility to awaken in the student the curiosity, the investigating, questioning and transformative spirit of reality" (Pinheiro, Silveira & Bazzo, 2007, p.77). Thus, according to the authors, implementing STS practices means overcoming the simple repetition of laws, allowing a reflection of political and social aspects, allowing students to question and develop rationality, thus demystifying the spirit of ST neutrality and taking political responsibility for them.

Thus, there are many justifications for the inclusion of STS practices in classrooms and in teacher education. These justifications vary from the reflection on factors that go beyond the Didactic Book (economic, political, environmental factors) to a purely motivational one. Referring to this aspect, Freire and Shor (1986) consider that "motivation must be within the self the act of studying, within the student's recognition of the importance that knowledge has for him" (p.15). Thus, we believe that in discussing models of STS curricula and implementing them in the educational context, we are contributing to the motivational aspect by broadening discussions and conceptions of citizenship, society, and technology in the student's own regional/local context (Auler, 2002). In this sense, authors present that:

> STS studies have assigned an important role to the historical and epistemological aspects of science and the interdisciplinarity in science and technology literacy. They indicate the need to explore knowledge under a broader character, taking a critical reflection [...]. (França, et al., 2016, p.4)

Another justification for the inclusion of STS practices is an approximation between students' school and experiential context as Lima and Barreto states: "[...] the best and most effective way to **link the content of books and the world of the student's** experience is through an approach that promotes the connection between science and technology with society " (2012, p.2, our emphasis). Therefore, one can see the indispensability of contextualising content to make it socially more relevant.

Thus, we see that there is a curriculum conception that considers as a starting point the world of life, the school community and its surroundings, where the student learns by participating, developing critical thinking, engaging in decision-making processes and being able to relate to theory with practice, praxis, making the living world its object of study (Muenchen et al., 2005; Santos, 2012).

We also emphasize the justification declared by a student, who recognizes that "The study of physics must be geared towards the formation of a conscious citizen, should be given in a simple and direct way, forming a citizen who is able to perceive his own impact alone [...]" (Paiva & Araújo, 2016, p.7). In this context, we realize that citizen and transformative education is also a pretext to bring discussions with a STS approach.

Thus, Araújo and Formenton show that the STS approach, when used as a problematizing bias, promotes:

> [...] important advances in students thinking about important STS and environmental relationships, highlighting a moderate increase in awareness of the fact that quality of life is worth more than the quantity of production and consumption, valuing the importance of "education for the sustainable development 'and' consumer education". (2016, p.7)

Finally, we understand and agree with Pinheiro, Silveira and Bazzo (2007) when emphasizing that "Education should contribute to the student's self-education, stimulating him to assume the human condition, encouraging him to live in order to become a citizen, which in a democracy will be defined by its solidarity and responsibility" (p.79), contributing to the student's active position in the face of present situations in society. Therefore, we believe that the STS bias allows investing in a transformative educational model that promotes reflection, interdisciplinarity and transversality in the thematic and controversial discussion of the educational reality in which students find themselves, by encouraging them to use connectivity and criticality to change its own context.

CONSIDERATIONS

In the walk, analysed in this work, which looks for signs related to the STS practices implemented in teacher education and in Basic Education, in the Brazilian educational context, we realize that the STS Approach is recurrent in productions of EPEF and journal EENCI. Over the years, their productions have gained greater proportions, but we still need to turn our eyes to their practice in elementary school and teacher education.

We observed through the Discursive Textual Analysis, the emergence of four categories, synthesized here, in an attempt to contemplate the objectives described at the beginning of this work: *1) Limitations of STS Practices implemented*, in which if we perceive to work in the perspective STS we need a greater time and space for planning, to break reductionist vision and the propaedeutic teaching; *2) Methodological aspects of STS practices*, we note that many practices implemented in teacher training seek the development of lesson plans, excluding their discussions, having a teacher preparation and that reverberates in classes without the teacher's mediation in the discussions. Since their training is still limited. In the classrooms, the STS approach is dealt with in seminars held by students, being a content parallel to the conceptual classes of Physics and other curricular components.

In the third category, *Social participation in the development of TC in classrooms*, we realize that we still need to break up banking education itself and encourage students to become social and questioning subjects. Where many students believe they do not

have the power of decision, since this is something of the "adult world", and does not belong to them.

The fourth and last category, *Justifications for the insertion of STS practices*, refers to bringing the context experienced in a certain region to the classrooms. Moreover, students for social importance and for scientific-technological knowledge is one of the objectives of the STS Approach. Nevertheless, it is still a challenge. For although the teaching of Science in the STS perspective is defended in the Academic field, there is still little repercussion in the classroom, properly speaking. In addition, when this occurs, often, the results are not as expected for a STS perspective education.

AUTHORS CONTRIBUTIONS STATEMENTS

R.A.S. supervised all phases of the project. C.P. and R.A.S. conceived the research problem, the research objectives, and defined and delimited the corpus of analysis. C.P. selected the corpus of initial analysis. D.M. and T.R.H. updated the selection of the corpus of analysis. D.M., T.R.H. and C.P. analysed the corpus according to the methodology of analysis adopted. All authors discussed the results and contributed to the final version of the manuscript.

DATA AVAILABILITY STATEMENT

The data supporting the results of this study will be made available by the corresponding author, D.M., upon reasonable request.

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