BIOE and the Teaching of Physics: inferences from the Critical Theory of Technology

Ingrid Aline de Carvalho Ferrasa (Corresponding author)
PhD student at the Graduate Program in Science and Technology Teaching at the Federal Technological University of Paraná - UTFPR, Ponta Grossa Campus, Brazil. ORCID: 0000-0003-4038-0469 E-mail: ingridferrasa@gmail.com

Awdry Feisser Miquelin
PPGECT - Federal Technological University of Paraná - UTFPR, Ponta Grossa Campus, Brazil. ORCID: 0000-0002-7459-3780. E-mail: awdry@utfpr.edu.br.

Maria Ivete Basniak
PPGECT - Federal Technological University of Paraná - UTFPR, Ponta Grossa Campus, Brazil. State University of Paraná (UNESPAR). ORCID: 0000-0001-5172-981X. E-mail: basniak2000@yahoo.com.br.

Sani de Carvalho Rutz da Silva
PPGECT - Federal Technological University of Paraná - UTFPR, Ponta Grossa Campus, Brazil. ORCID: 0000-0002-1548-5739. Email: sani@utfpr.edu.br.

Abstract

This article reads from Andrew Feenberg's Critical Theory of Technology, analyzing the International Bank of Educational Objects (BIOE) in Physics teaching, investigating whether the Educational Objects (EO) available in BIOE contemplate a process of teaching and learning that is critical and reflexive and that articulates with one or more pedagogical conceptions linked to its educational objective. For this, the qualitative approach of the documentary type was used for data collection and content analysis to arrive at the results. Thus, we verify that the EO for Physics available in BIOE do not contemplate a critical and reflexive teaching and learning process articulated to one or more pedagogical conceptions linked to its educational objective; it does not broaden the problematization related to educational practices in physics towards the politicization of science and technology, in understanding the implications of an educational technology; and it is absent in the very understanding of human relations with such objects and the systems in which they operate, including the teaching and learning process.

Keywords: BIOE; teaching and learning of Physics; Critical Theory of Technology; Educational Objects.

1. Introduction

The accelerated change of a society is directly proportional to its mastery of knowledge. The human being of this society, endowed with reason, enhances knowledge in the sense of innovating. Innovation extracts new knowledge, whether theoretical or practical, and this knowledge, when put into practice, can generate instruments and/or products. Such logical relation here ascribed attributes to science and technology as entities represented by human reason. However, this look carries with it aspects that require further study.

Andrew Feenberg (is a philosopher born in 1943 in the USA. He currently serves as chair of the Canadian Center for Research in Philosophy of Technology at Simon Fraser University School of Communication in Vancouver), a philosopher and technology scholar, presents among some of his studies the Critical Theory of Technology. In this theory, the implications of the relationship between science and technology, according to the author, are to compensate for the disaster of modernity (Feenberg, 1991 and 2007). As they turn out today, both are unable to promote humanity's true development that provides economic equity, social justice and environmental sustainability. Feenberg (2010a) attributed that the human potential for knowledge generation carries with it interests and values that are not compatible with what he calls the alternative and well-intentioned style of science and technology, which can be translated as those focused on citizenship. Thus, it contributes to the understanding that in order to harness the full potential of scientific and technological development and to use it on the basis of the fight against inequality and the promotion of inclusion, the discussion of science and technology in the world must be politicized. (Feenberg, 2010a).

To this end, programs aimed at online education are classified today within the context of the so-called Educational Objects (EO). These objects refer to any digital resource as a supplement to the learning process (Tarouco et al., 2014). Thus, to aggregate such resources in a single environment and facilitate interaction with the user, digital education repositories such as the International Bank for Educational Objects (BIOE) were created.

BIOE presents the EO cataloged in accordance with the levels of education provided for by the Law of Guidelines and Bases of Education (LDB) in the country (Ruas, 2012), including Physics. Articulating numerous digital EO collaboratively with open access, this repository aims at democratic education (Afonso et al., 2011). Therefore, we ask: do the EO for Physics available at BIOE contemplate a critical and reflective teaching and learning process that is linked to one or more pedagogical conceptions linked to its educational objective?

Although a first reading of Andrew Feenberg's Critical Theory of Technology is presented, in order to explore BIOE's digital technology far beyond its appeal, we are attempting to contribute to the construction of elements that provide grounded reflections for possible actions in dealing with technology in the educational context.

2. Andrew Feenberg's Critical Theory of Technology

For Andrew Feenberg (2009), formulating the Critical Theory of Technology needed to achieve two distinct objectives: the first is to distinguish the so-called traditional conceptions of technology, delimiting the instances of reflection of philosophy and, the second, to put a new relationship between his understanding

of technology with that of the Frankfurt School (Formed by philosophers, sociologists, psychologists, among others, the Frankfurt School (in Germany) was motivated by Karl Marx's theories. The implications of technology, for example, were discussed in modern capitalist societies, of which the ideas of Hebert Marcuse (philosopher and sociologist) and Jurgen Habermas (philosopher and sociologist), were analyzed by Feenberg generating a new look at technology in modern society). In this respect, this section presents the main theoretical elements on which Feenberg bases his Critical Theory.

The Critical Theory of Technology is defined by the relationships that technology has with society. For Feenberg (2009), any conception of technology that has a neutral, autonomous character and that responds to an unfavorable fate of society is discarded. Human beings need to understand technology as historical development, according to the ways in which the social world is structured and the services it provides (Feenberg, 2002, 2005a and 2009).

Based on Marcuse's ideas, Feenberg (2005) states that technology is linked to scientific rationality, so as to instill control throughout society, masked by technological rationality. Marcuse classifies technology as the instrument by which dominant social classes control the modern world. Although I agree with Marcuse in this respect, for Feenberg (1999) the attributes given by him, about the social control exerted by technology and the transformations in response, occur also by other determinant actions.

In addition to Marcuse's ideas, Habermas's ideas contribute in a way to Feenberg (2005) pointing out the determining actions that constitute his theory. According to Habermas (1993), a technological revolution is one that enables only a new relationship of humans with the world, and does not bring a new technology, because it is the result of a historical development of humanity. Feenberg criticizes Habermas's neutral stance, although he articulates his ideas with Martin Heidegger's on the instrumentalist side of technology, agreeing with Marcuse's ideas about technology being politically biased (Feenberg 1995 and 2009).

In this context, it is in the Instrumentalization of Technology Theory, based on the conceptions of Heidegger (technology incorporates essential values), Habermas (neutral technology) and Marcuse (biased technology) that Feenberg seeks to clarify how social interests are placed in the context of the technology and how it can be transformed in a way that frees society from being controlled by political power. In Instrumentalism, technology, according to Feenberg (2010c), is provided with a liberal and positivist optimism, aiming to satisfy the needs of society, as it is neutral in relation to moral or political values. Instrumentalism contemplates the field of study of the Philosophy of Technology, as well as the Substantivist Theory.

With premises also in Heidegger and Jacques Ellul, the Substantivist Theory of Technology has control over man, embodying values that nourish it, make it autonomous and manage its own development, against the optimism preached until the mid-1950s (Feenberg, 2005). For the Substantivist Theory, technology is a threat to the humans who make up modern society. This theory is a marxist/pessimistic critique of the Frankfurt School, with capitalist values and interests embodied in it (Feenberg, 1999 and 2005).

Another theory that adds contributions to the philosophy of technology is the Deterministic Theory of Technology. According to Feenberg (1995), this theory is premised on the consequences of technology in society as essential to human beings. Theory departs from science to assign functionality to technology. Sharing the instrumentalist (neutral technology) and Substantivism (autonomy) conceptions, Determinism points to technology as the only means of progress in modern society.

Feenberg, when he was in Brazil in 2010, at the Critical Theory of Technology Conference Cycle, defined what a modern society is mediated by technology. For him, it is one in which the basic needs are not met to all humans equally, there is no continuous proposal of Instrumentalism and Determinism as the basis for humanity. In this modern society, people migrate after technology, not only for its progress, but for hope (Feenberg, 2010a). This definition of modern society by the author demonstrates that mastery of technology increases the power and control of its owner.

In this deterministic context of technology, according to Feenberg (2010c), with an optimism inherited from Marx, the hope in which modern society is directed is employed by those who hold the technological power, which shapes and pushes society, demanding efficiency and progress. This society oppresses the masses in order to lead them to a single liberation through socialism. That is, within the deterministic conception, technology is the only form of progress.

A modern society has certain characteristics that end up characterizing the nature of human beings as human. Feenberg (2010c) portrays the human being who is part of a modern society in the context of his/her own subsistence. He mentions family reunion times for meals. In a modern society, these moments are replaced by technical feeding systems, which enable human beings to quickly satisfy their appetite, optimizing their time to continue producing, just like a machine. The author establishes a relationship between human mechanization and the increase in self-help books in bookstores, which Heidegger was already criticizing, stating that humans are entering a world of decline and without hope for the situations they face due to technology (Feenberg, 2010c).

In this regard, Feenberg's (2009) theory reveals that it is possible for humans to relate to technology, and not lose their humanity, with actions directed to the politicization of science and technology, and defines their theory as a political theory of modernity. For the author, this theory contemplates a committed and optimistic stance in social construction, to be projected through the values and interests of the institutions where technology is produced, since Marcuse in the 1950s pointed to the frustrated potential of science and technology if they are left under the exclusive appropriation of capitalist productive systems and markets. Politicizing technology means bringing it into the public sphere, with discussions and reflections, in order to appropriate a technology suitable for humans.

Thus, Feenberg (2009) defines his theory in a generic way as a political theory for modernity. Technology in modernity, according to the author, is subject to the rationalization of political powers, which, while turning to the demands of social classes, increase their power through technology, defining modern society. Technology in modern society is inscribed in a concept called the technical code, defended as a set of norms and social interests implicitly implicated in the construction and development of a particular technology, which assumes its biased aspect (Feenberg, 2002). This code is generally not part of the common sense of modern society and behaves like a black box, which does not open to explanations of what is inside. According to Neder (2010), both Instrumentalism and Determinism portray technology as a black box.

For Feenberg, humans need a policy of rationality, because it is urgent that they fight for technology and the opening of black boxes beyond the domain only of instruments, such as the internet, which also puts human beings in conditions of subordination. To remove human beings from this condition, Neder (2010) reveals Feenberg's engagement: “[...] the internet itself as a universal and open source communication system - a struggle in which Feenberg engaged from the 1980s onwards to demonstrate their role in

interactive education [...] ”(p. 16). In this context, BIOE is presented below, in order to understand its implications for the teaching of Physics.

3. The BIOE for the teaching of Physics

With funds from the Inter-American Development Bank, the Ministry of Education (MEC), articulating partnerships with the Ministry of Science and Technology (MCT), the Organization of Ibero-American States and the Latin American Network of Educational Portals creates, in the year 2008, the BIOE (Available at: http://objetoeducacional2.mec.gov.br/ (until the year 2013). And http://www.labtime.ufg.br/bioe (after the year 2014).

BIOE is a repository, that is, a set of services offered by a society or organization, according to Monteiro (2009), for management and dissemination of knowledge in digital media (*apud* Binotto *el al*., 2012). BIOE's goal is to stimulate and support the processes of teaching and learning in different countries by making EO available in different languages to educational policy managers, school managers, researchers, teachers, students and the general population for digital inclusion and the socialization of knowledge (Brasil, 2019a).

The EO hosted in the repository until 2013, meet the modalities of Early Childhood Education, Elementary School, High School, Vocational Education, Higher Education and the modalities of teaching of Young and Adults and Indigenous Education, in the categories: animations, simulations, audios, hands-on experiments, hypertext, images, maps, educational software, and videos. After 2014, the EO bank hosted on a new website, under the responsibility of the Information Technology and Educational Media Laboratory (LabTime) of the Federal University of Goiás (UFG), replaces the Youth and Adults and Indigenous Education modality by Teaching modalities and offers Professional Education, in the categories: image, exercise, simulation, experiment, hypertext, application, text, audio, video and slide.

Part of the EO available at BIOE, according to Bielschowsky and Prata (2010), results from actions sponsored by MEC and third parties. The repository integrates your data from programs such as TV Escola; Public Domain Portal; Program of the Virtual Interactive Education Network (RIVED), of the Secretariat of Distance Education (SEED); and digital content of the MEC/MCT public call 01/2007 (Available at: www.finep.gov.br/chamadas-publicas/chamadapublica/34). In the latter, twelve Brazilian institutions contributed to high school projects; also institutions like: University of Colorado, California, Utah, Medical Institute, NASA, University of Hong Kong, Alicante of Spain, Institute of Physics of England, and Skoool of Ireland; with internet content; and interested collaborators.

BIOE (on both sites) is freely available under license *Creative Commns,* which freely distributes a copyrighted work. In it, the author enjoys his production freely, even negotiating it commercially, since the data when available at BIOE is not the property of MEC. However, for other users, the repository is for educational use only, prohibited for profit (Silva, 2009).

To start a search for BIOE-hosted EO (by 2013), the user can choose from simple search, filter search, and advanced search features. The simple search takes place by the EO information and in the filter search the country, the language and the type of resource can be informed and the advanced one has the conjunction of the logical operators *and*, *or* and *and not*. The search criteria for EO hosted after 2014 on a new site are

organized into: search type, language, educational level, resource type, large area, sort by and search.

Since the initial project in 2008, all the necessary technical maintenance at BIOE has been in charge of the University of Brasilia, institution responsible for building the repository. The EOs presented at the bank were attended by a cast of three hundred (Number of stakeholders for 2010, according to Bielschowsky and Prata (2010)), involved, including students and professors from some of the country's universities (Bielschowsky and Prata, 2010). According to Melques et al., (2010), the specialists (students and professors) responsible for the organization and maintenance of the repository were from the Paulista State University of Presidente Prudente (UNESP), University of Brasília (UnB), Federal University of São Carlos (UFSCAR), among others. However, we can see that support for BIOE (http://objetoseducacionais2.mec.gov.br/), repository hosting services, with EO hosted from 2008 through 2013, has not been occurring periodically. Many times, the site is down, or has problems with the Domain Name System (DNS) server, or the hosting network. For this year 2019, we observed in some of the searches made that such situations are still frequent. Thus, from 2014, LabFime UFG will perform technical maintenance, with experts contributing in the organization of metadata present in the repository in new site (http://objetoseducacionais2.mec.gov.br/)

The metadata of an EO, according to Tarouco et al (2003), is defined by the description of the relevant characteristics of the object in a repository, so that it can be cataloged and retrieved later. Due to the articulation between the*technology* and the *information*, according to Silva et al., (2010), debates and initiatives in society have been increasing to make self archiving, collaboration and free access to didactic resources available. directed to teaching. In this regard, we emphasize the importance of BIOE EO prior to 2013 being available for research.

Related to the area of Physics, Paloma Ruas, from UNESP Presidente Prudente, was from 2008 to 2011 aiming at the dissemination of knowledge in BIOE. According to Paloma: “My role in BIOE was to research, select, evaluate and catalog SOs located on websites, to make them available within this repository [...]” (Ruas, 2012, p. 20). Streets, at that time, represented the first committee of BIOE, performing the validation of EOs, so that, by other evaluative technical and pedagogical criteria, the specialists of a second committee of the Ministry of Education reevaluated them, so that the object would be part of the repository, posteriorly. According to Melques et al. (2010), BIOE offers professors especially alternatives to a traditional class, causing a change in the pedagogical paradigm.

The BIOE repository, which hosts OE until 2013, has a total of 19,842 EO, with 52 countries registered in the database in 11 different languages (Brazil, 2019a). Regarding the EOs that contemplate the area of Physics, a total of 2192 EO are part. Table (1) below shows the number of publications for each BIOE EO category:

Table 1: Number of EO publications at BIOE until 2013:

High School Category	Total
Animations and Simulations	927
Audios	89
Practical Experiments	421
Hypertexts	8
Images	219
Maps	0
Educational Software	4
Videos	524

Source: The authors (2020)

Yet, the repository of BIOE from 2014, hosts in a new site, a total of 1756 EO in different subareas of Physics (Brazil, 2019b), according to table (2):

Table 2: Number of EO publications at BIOE after 2014:

High School Resource type	Area	Total
Image	Elementary Particle Physics and	2
Exercise	Fields	
Simulation	General Physics	518
Experiment	Condensed Matter Physics	5
Hypertext	Fluid Physics, Plasma Physics and	7
Application	Electrical Discharges	
Text	Atomic and Molecular Physics	12
Audio	Classical Areas of Phenomenology	1193
Video	and its Applications	
Slide	Nuclear Physics	19

Source: The authors (2020)

Even in the face of a number of expressive publications in some categories, as shown in Table 1, making a more systemic search of EO, it is possible to realize that some are unworkable. For each of the EO categories provided by BIOE, we conducted research seeking to know the materials available for working with Physics.

Table 2 presents the EO categorized according to the BIOE, in which the publications in the area of Physics are systematized. Although the last update of the site is from the year 2017, we observed publications hosted between the years 2014 and 2015.

It is important to note that such EO are hosted at different email addresses, however, with the same search name. We do not see MEC justifications for upgrading the bank on another site, let alone a warning that indicates to the user that BIOE also operates at another email address from 2014.

We chose to categorize the two sites in the tables, because the EOs available on both are not fully replicated. However, as the objective of this research is not limited to the validation and execution of software, simulations, among others in the repository, we justify to present here only a panorama of the repository for the teaching and learning of physics, in order to make known how the even if it is organized (tables 1 and 2).

Thus, in order to present an answer to the problem that guides this research on such EOs in the area of Physics at BIOE, a critical and reflexive teaching and learning process that is linked to one or more pedagogical conceptions linked to its educational objective, the reflections presented here are based on the qualitative approach of the documentary type for data collection, based on the content analysis (Bardin, 2004) of the BIOE EO. Thus, a first reading of Andrew Feenberg's Critical Theory of Technology is presented not limited to BIOE's digital resource, but in the sense of understanding the relationship between humans and nonhumans when technology is imbricated in the teaching and learning process.

4. Some considerations from Critical Theory of Technology to the International Bank of Educational Objects (BIOE) in the teaching and learning of Physics

As discussed in the previous section, the understanding of human relationships with technology and the systems in which they operate is portrayed by Andrew Feenberg (1995, 2002, 2005a, 2010a, 2010b and 2010c) from the studies of Marcuse, Habermas, Heidegger and Jacques. Ellul The author presents his Critical Theory of Technology as a means of architecting human intellectual conditions for a reform of technology within different contexts of modern society.

One of these contexts inserted in modern society refers to educational technologies. The Internet, as a technological communication medium (Moran, 2001), was one of Feenberg's struggles to insert it into the educational context, aiming at human beings' access to knowledge. Despite the Instrumentalist view that modern society takes on technology, followed by Determinism and Substantivism, which summarize technology as an object and/or instrument of a character neutral to the desires and interests of man, and as a form of progress, Feenberg did not have There is no doubt that the Internet should be present in education as a strategy to streamline the teaching and learning process, as it “opens up fantastic opportunities for human communication” (Feenberg, 2010a, p. 143).

On the internet, according to Moran (2001, p. 22): "One of the challenges is how to turn information into knowledge and wisdom." It is noticeable how digital technologies have gradually occupied the school environment. Although the presence of technological devices is effective, they end up being simply facilitating means for accelerated dynamics, be it bureaucratic services of school management or didactic contract (Ferrasa and Miquelin, 2008), established between the student, the teacher and knowledge. The internet enables browsing and information retrieval, but needs to be connected to the characteristics of the target audience inserted in the pedagogical process (Santarem Segundo et al, 2010).

Considering the vast field of information and knowledge available on the Internet, educational repositories, according to Binotto and Basso (2012), are much more than deposits of specialized information, they are knowledge organizers. The repositories seek to organize EO in order to contribute to the construction of knowledge by the involved, and serve as a support to the process of teaching and learning at school, and

are suitable for those who somehow want to acquire relevant information. However, it is possible to observe that some digital repositories end up summarizing EOs as tools of use (Afonso et al., 2011; Binotto and Basso, 2012 ; Grégio, 2011; Melques et al., 2010; Silva, 2009; and Ruas, 2012).

The BIOE repository, which hosts a variety of EO, aims to make digital materials available as tools for education. With a proposal directed to the use of technologies for education, a pedagogical conception that supports it is missing in the repository. Particularly in the area of high school Physics, a conception that founds and/or characterizes the educational objects available in it is also absent. Although with the glasses of Feenberg's Critical Theory of Technology, the practical application of an EO as a tool for use in a learning context is directed to Instrumentalism, it is believed that it may be linked to the very formative conception of the researchers responsible for BIOE. who are unaware of the *theories* of technology, or even of the sociopolitical system itself of modern society, which aims at Determinism and Substantivism.

What actually happens is that humans in modern society are unaware of the manipulation of their own society and enjoy the masked Determinism and Substantivism to believe that they have technological control and that technology is for their own good. be. From this, when questioning what humans should do, Feenberg (2010a) points out possible actions to remove man from his condition imposed by politicizing technology. In addition to the democratization of technology in modern society (Feenberg, 2010a), politically educating society allows the rescue of humanization of human beings. This involves understanding that the human relationships implied in technology are crucial, first, for the human to continue assuming his/her role as human and, in a second aspect, for not being dominated by technology and losing his/her humanity.

Most modern theorists, according to Feenberg (2005), overlook the efforts and innovations of those interested in appropriating computer science by creating online communities or engaging in educational innovations. This means that to ignore or not to admit these aspects is to go back to Determinism and Substantivism. In this respect, the works of Ruas (2012); Binotto and Basso (2012); and Grégio (2011), directed to the process of teaching and learning Physics in the context of BIOE, report educational proposals using the repository as a tool for the training of physics teachers; and in dynamics differentiated by the use of technology with the repository EO. Feenberg (2005) considers the efforts of those who, in one way or another, engage in incorporating technology into the educational realm, although it warns of two emerging situations: one in which stakeholders do not give up creating conditions for humans. consciously share and enjoy technology, not limited to conditions imposed by modern society, and another to discuss and place technology at the center of controversy (Latour, 2002).

Feenberg points to the existence of a much deeper relationship involved between humans and the *world of things* available on the Internet. Thus, human beings' discussions and problematizations about the *state of things of technology* can open new paths for study in order to alert modern society. Especially in the BIOE repository in the area of physics, it can be observed that, since its creation in 2008 (table 1), for the category animations and simulations of EO, the last publication dates from 01/07/2013. In other EO categories like: videos and hands-on experiments, the latest post corresponds to 02/16/2014. Also, among the available EO, many of the link access addresses are outdated or incorrect, making it impossible to access them. And for EO hosted on a new site from 2014 onwards, for the categories and subcategories listed in table 2, the postings begin on 7/30/2014, ending on 3/27/2015 in the following categories: general physics and classical

areas of phenomenology and their applications. We can see that the EO available in the repository hosted from the year 2014, are very well cataloged and with due credit to the authors and information needed by the support user to use the EO. However, user access to it via the BIOE website does not occur.

If initially the proposal of BIOE was to provide digital educational material, it is noticeable that the repository maintenance has not been done in the area of Physics since 03/27/2015, (considering only the BIOE website under the responsibility of LabTime UFG), These objects could contribute directly to the politicization of technology. This reality shows what Feenberg (2010a) has been warning about technology neutrality imposed by modern society. Every investment and partnership made to get the repository technology up and running has been lost over the years. If proposals for technological innovation applied to education were implemented in public policy with each change of government, there would be no closing of existing proposals (Basniak and Soares, 2017). Feenberg (2002) states that the ethical and moral values of human life do not seem to interfere in the world of technology. There is a parallel universe to real life, in which the human being, when he/she feels the need, uses it and then leaves it until he/she feels the need or wishes to use it again.

Feenberg's theory has, above all, been devoted to interpreting the world in the light of its potential and enabling a new discussion of the educational process in modern society. The fact is to clarify the naive and simplistic character employed by modern society to technology (Dagnino, 2006). Feenberg encourages human beings to dare to confront the prejudices of modern society, which confine research and study to narrow channels, because boldness enables favorable prospects for the future (Feenberg, 2010a). It also places humans in the opening of technology's black boxes, not summarizing them to objects, but incorporating them into relationships, which humans are entwined with. “From an epistemological point of view, by opening the black boxes, it will be possible to visualize the foundations of a scientific theory, [...] establishing principles for breaking with common sense” (Carvalho, 2007, p. 96).

Although in the Instrumentalist perspective, technology is open to functional analysis and interpretation, a technological means understood only by the functional aspect, inserted in the context of education, entails, according to Feenberg, a neutral character and without values essential to technology. The context of technologies in education articulated to the teaching and learning process of physics behaves like black boxes, in the sense that there are still open fields of study to understand how to articulate Feenberg's Critical Theory of Technology to the instances of the process. Physics

Science, endowed with its knowledge, does not represent objective truth, and technology is not limited to the practical application of scientific knowledge (Feenberg, 2010a). For the author, science and technology are social constructions in different scenarios, are aggregate of values and represent knowledge. From constructivist studies, Feenberg directs his philosophy in the context of social, political, cultural, and political-cognitive implications for a knowledge society.

Educational conceptions are at the service of conducting teaching practice, even those directed at technology. An educational conception that conducts work with an educational technology, for example, would support the pedagogical activity at BIOE, which could subsidize the process of teaching and learning in the repository in a critical and reflective manner. It is important to stress that an educational design does not guarantee the success of a technological innovation proposal for education, as there are many political issues involved. The epistemological and gnosiological foundations that systematize educational

conceptions, aggregate inferences that organize and nourish the scientific-educational knowledge of the teaching practice area. In this respect, an educational conception can also nourish the process of technology politicization in the teaching and learning processes, since the educational conceptions are built by the most diverse areas of knowledge.

However, humans are constantly challenged with technology today(Lyotard, 1989). For Kensky (2012), technology is power. In all kinds of social relations, there are links between knowledge, power and technology. For Feenberg (2010a), society is organized around technology; the greater the technological power, the more powerful the society. According to the author, the only chance that humans can keep up with technological development is to adapt to this imposed complexity, because technology is not neutral, adds value and sets standards. This is also the challenge of education: adapting to advances in technology and guiding the way in the domain and critical appropriation of technology. Teachers can create conditions for technology to be rectified, transformed, accepted, prohibited, among other things, by creating a society that is not at the mercy of its own modernism.

Technologies combined with the need to learn within a universe without physical barriers have been presenting new trends in the teaching and learning process. In the last decade of the twentieth century, the use of these resources, even if still elementary, allowed access to educational content from anywhere and at any time.

Humans still crawl for technological innovation in education. This is, we believe, by the unconscious manner in which they are subjected to a masked system of domination. Proposing new fronts of action to a technological education enables the construction of a new awareness for new educational actions, including those involved in working with BIOE.

Feenberg presents his ideas by understanding them from the relationship between the functional and social dimension, thus offering us a democratic theory. The author goes beyond the problems of technology to social interests and the paradigm of its efficiency, a feast of scientific-educational conceptions in the teaching of science and technology, by revealing a *practical* conception of technology, that is, that it is open to technology. any kind of transformation, nullifying their traditional conceptions in modern society.

5. Conclusions

According to Feenberg, traditional theories of technology develop reflections only from the functional dimension. The theory of instrumentalism and determinism excludes hermeneutics, and technology is viewed as an object of analytical reflection and its functional performance. Substantivism destines a tragic future for humanity. Even if technology determines social values, while not acting reciprocally for society, Feenberg's Critical Theory of Technology opens new paths for problematizing the current *state of the art* of educational technology at BIOE.

Aspects related to the human domain and irrational actions towards technology can be debated and reflected in the educational context. Placing at the center of the controversies an educational repository, such as BIOE and its implications, shows how much human beings still need to open and remove technology from the black box condition. We point to the educational process of human beings as a means to build their consciousness, with intellectual conditions to systematize actions in order to live with technology without

being dominated by it. It is important for humans to realize that politicizing technology, as Feenberg (2002) points out, can be a way of leaving their subordination to it, placed by political and economic systems. We believe that education is that way.

At a first analysis of Feenberg's Critical Theory of Technology, in the context of BIOE directed at the teaching and learning of Physics, we verify that the EO for Physics available in BIOE do not contemplate a critical and reflexive teaching and learning process articulated to one or more pedagogical conceptions linked to its educational objective; it does not broaden the problematization related to educational practices in Physics towards the politicization of science and technology, in understanding the implications of an educational technology; and it is absent in the very understanding of human relations with such objects and the systems in which they operate, including the teaching and learning process. Although the EO do not present a pedagogical conception to their educational objective, the arguments elaborated here can contribute directly to the work with such objects in the Physics teaching, even from the perspective in which they are presented.

This research, in addition to contributing to the existing educational implications for technology, enables new perspectives on technologies in education, these beyond the product, beyond the technique, practice, politics, social aspect, or even, beyond the human. Politicizing science and technology in social organizations creates conditions for humans to be aware of their purpose, what each or both of them want, what they do to humans, and what humans do to them.

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7. References

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