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Andrew Feenberg and the environmental question: philosophy of technology, environmental education, and technological progress

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ABSTRACT

We propose here a theoretical essay that problematizes environmental education (EE) based on the contribution of Andrew Feenberg's philosophy of technology, in order to philosophically substantiate the need to consider democratic aspects for this educational practice. Assuming that environmental problems require an interdisciplinary dialogue, the text proposes a theoretical analysis that connects the concept of "technical code", developed by Feenberg, to the need to democratize technological development and integrate it into EE. Based on Feenberg, it is argued that EE must go beyond the mere criticism of technical and functional efficiency, by questioning the values underlying the technologies adopted. To this end, interdisciplinary dialogue is essential, allowing us to understand and transform the hegemonic technical codes that impact the environment. We conclude that emancipatory EE must promote two central aspects: knowledge and transformation. In addition to enabling individuals to understand the impacts of technologies, it is necessary to politically mobilize groups to confront antidemocratic values inherent in certain technological solutions. More than that, it is possible to think of an EE that, instead of fighting any kind of progress, is able to be open to a type of technological progress that strengthens a model of democratic and environmentally responsible society. Thus, the proposal is articulated as a combination of technical and ethical-political literacy, inspired by Feenberg's philosophy, and highlights the importance of an educational process that integrates critical reflection and social mobilization in favor of rewriting the accepted technical code.

KEYWORDS: Environmental education (EE); Interdisciplinarity; Philosophy of technology; Democratization of technology; Feenberg.

Andrew Feenberg e a questão ambiental: filosofia da tecnologia, educação ambiental e progresso tecnológico

RESUMO

Propomos aqui um ensaio teórico que realiza uma problematização da educação ambiental (EA) a partir da contribuição da filosofia da tecnologia de Andrew Feenberg, no sentido de fundamentar filosoficamente a necessidade de considerar os aspectos democráticos para essa prática educativa. Assumindo que os problemas ambientais exigem um diálogo interdisciplinar, o texto propõe uma análise teórica que conecta o conceito de "código técnico", desenvolvido por Feenberg, à necessidade de democratizar o desenvolvimento tecnológico e integrá-lo à EA. A partir de Feenberg, argumenta-se que a EA deve ir além da mera crítica à eficiência técnica e funcional, ao questionar os valores subjacentes às tecnologias adotadas. Para isso, o diálogo interdisciplinar é essencial, permitindo compreender e transformar os códigos técnicos hegemônicos que impactam o meio ambiente. Conclui-se que a EA emancipadora deve promover dois aspectos centrais: conhecimento e transformação. Além de capacitar indivíduos a compreender os impactos das tecnologias, é necessário mobilizar politicamente grupos para enfrentar valores antidemocráticos inerentes a certas soluções tecnológicas. Mais que isso, conclui-se a possiblidade de pensar uma EA que, em vez de combater qualquer espécie de progresso, consiga estar aberta a um tipo de progresso tecnológico fortalecedor de um modelo de sociedade democrática e ambientalmente responsável. Assim, a proposta se articula como uma combinação entre letramento técnico e ético-político, inspirada pela filosofia de Feenberg, e destaca a importância de um processo educativo que integre reflexão crítica e mobilização social em prol da reescrita do código técnico aceito.

PALAVRAS-CHAVE: Educação ambiental (EA); Interdisciplinaridade; Filosofia da tecnologia; Democratização da tecnologia; Feenberg.

INTRODUCTION

There seems to be a broad consensus regarding the urgency of regional and global plans for environmental education (EE). Nonetheless, the complexity of this topic of study – as well as the complexity of the object itself – points to numerous different paths: many of them complementary, others contradictory. This same complexity evokes the need for an interdisciplinary effort, since no single discipline would be sufficient to address the issue in a minimally satisfactory manner. In the case of philosophy of technology, the problems involving the relationship between the environment and society have given rise to various theoretical reflections. However, when it comes to EE, these theoretical paths must necessarily establish a dialogue with other disciplines, otherwise they will remain limited to the conceptual scope. Our intention is certainly not to offer a complete plan for EE, but to point out possibilities for dialogue between philosophy of technology and the interdisciplinary approach that this issue requires, in order to contribute to the theoretical foundation of this complex area of study.

Among the many possible biases, in this article we propose a dialogue with Andrew Feenberg's thinking. This author's work has already been investigated with the purpose of exploring its conceptual potential to address EE (cf. Nascimento and Souza, 2023). Although, elements that relate technological development to the educational process, in sight to questioning the progress model to be adopted, according to Feenberg, do not seem to have been very well explored. Thus, since technological development democratization is a central element in this author's thinking, we propose the question of how EE can be inserted into this democratization process, and how interdisciplinary dialogue participates in this process. However, as an important point, we want to relate his analysis to the topic of compatibility or incompatibility between technological development and environmental preservation. Such questions are seen as an attempt to, at the same time, deepen and expand the author's thinking, which deals with democratization in a broad sense, to the specific issue of EE, taken in its theoretical, philosophical foundation.

Other authors considered relevant to the proposed issue here will be mentioned, as they establish contact points with Feenberg's thinking. Among them is Thomas Kuhn, a philosopher of science who yielded a profound reflection on the processes that guide scientific activity and culminate in scientific revolutions. More specifically, it will be of interest to understand how Feenberg uses Kuhn's concept of *paradigm* to interpret issues related to environmental problems. The concept of "technical code", as developed by Feenberg, will be central to this analysis.

Therefore, what we propose here is to carry out a theoretical essay, based on conceptual reflections and analyses, based on some of the main texts by the author in question (including Kuhn), arguing that there are, in Feenberg's thinking, good arguments to support the relationship between EE and technological progress, without establishing an opposition between them.

ENVIRONMENTAL EDUCATION AND TECHNOLOGY

It would be risky to assume that there is a fixed – that is, definitive – definition for the term "environmental education". Various approaches have been

presented, as there is a history that gathers many decades of reflection on the problems caused to nature by human action. Already in the 1970s, the famous Club of Rome, formed by an interdisciplinary group of experts (cf. Meadows et al., 1978), compiled data on pollutants, with the aim of provoking reflection on the future of the planet and its capacity to withstand the emission of such pollutants in the process of countries' economic, industrial and agricultural development. Thus, a discourse of caution regarding the future of the planet emerged:

> This ignorance about the limits of the earth's ability to absorb pollutants should be reason enough for caution in the release of polluting substances. The danger of reaching those limits is especially great because there is typically a long delay between the release of a pollutant into the environment and the appearance of its negative effect on the ecosystem. (Meadows et al., 1972, p. 81).

In other words, environmental issues became relevant and were increasingly present in discussions about the future of the nations, given the uncertainties regarding the limits of the planet's ability to withstand pollution.

Ergo, given the connection each time more evident between environmental and social problems, EE has been treated as something fundamental for the formation of citizens. To this end, the need to make explicit the social and political dimension of such education becomes a central demand. This is what Reigota (2009, p. 12-13) does when he suggests that EE should be understood as a political education, distinguishing itself from the firsts EE models, which were closer to a "biological ecology", whose intention was solely to deal with the "disappearance of species". That is, it is not about dealing with the extinction of species threatened by various causes, including pollution, without delving into the social and political issues involved. This is also present in what Logarezzi (2006) highlights about EE. It should be understood as containing a "critical, emancipatory and transformative" aspect. This implies the need to define EE as:

> [...] educational activity that integrates knowledge, values and political participation related to environmental issues, with the aim of promoting the process in which people educate themselves in the personal and intersubjective search for awareness regarding the environmental crisis and the role that each person plays as co-responsible for the problems and about the possibilities of each person participating in alternative solutions, seeking to awaken a citizen's commitment, which includes the private and public spheres and in the local and planetary dimensions (Logarezzi, 2006, p. 86-87).

This type of definition of EE interests us here, because it is not about isolating knowledge about nature without observing the relationship it maintains with human aspects. Questioning the model of society we want is part of such a process.

Even today, it remains a challenge to think about implementing EE in educational institutions. As Santos and Kataoka (2022) suggest, it is possible to observe progress in the implementation of EE in the training of some professionals, especially those directly linked to the study of life, such as biologists. This study is accepted in the sense of recognizing the existence of the interconnection between environment and society (socio-environmental conception). However, many challenges still exist, mainly regarding the practical implementation of EE, considering "critical actions contextualized and involving the different dimensions of the environment" (Santos; Kataoka, 2022, p. 12).

In turn, even though implementation challenges are still real, fundamental aspects seem to have their own demands. This is the case with the difficulty of considering the centrality of technological development in relation to environmental problems. To what extent can EE benefit from a philosophical understanding of this relationship?

The author who is the central focus of our essay, Andrew Feenberg, highlights the inevitable connection, in the contemporary context, between technology and its effects and, consequently, between technology and the sectors of the population that it affects. He presents some examples, such as labor issues and, the one that interests us most here, environmental issues. As we will see below, Feenberg admits a co-construction between society and technology, in such a way that it is not possible to delimit an absolute beginning for their mutual influences. Thus, if a sector of the population is particularly sensitive to the effects of a certain technology on the environment, political mobilization will be necessary to bring about a change in the technical code that governs this technology. In the example of the labor context, child labor was closely linked to the technical structure of the factories, so that the machines were all adapted to the small bodies and small hands of the workers. Part of society, dissatisfied with this situation, organized to promote a change in labor laws and review the technical code that had been dominant until then.

As an example, environmental issues – which in contemporary times can be summed up by the term “environmental crisis” – can only be addressed through a dual approach. On the one hand, it is essential to consider technology, in Feenberg’s terms, as the “material structure of modernity” (Cupani, 2004, p. 508) and, in this task, the philosophy of technology can provide the theoretical and conceptual foundation. On the other hand, a transformation is needed that goes beyond the theoretical scope and finds in EE sufficiently transversal and emancipatory means. Maturing the dialogue between these two areas is important to contemplate this aspect of the complexity that surrounds and permeates environmental issues.

The transformative power of EE, from this perspective, must be considered from the perspective of the tension with the topic of technological progress. In the historical illustration of child labor, Feenberg addresses not only the democratic process, in seek of changing the technical code, but also the compatibility of this change with technological progress. The question that arises is whether, as those who defended child labor claimed, the change in the structure of factories, necessary to accommodate adult workers, would cause some kind of technological or economic setback. History shows that the economy survived this change. Although, when it comes to technological progress, the issue is more complex. Especially when it comes to the environmental issue, it is often argued that the price to pay for environmental preservation would necessarily be the stagnation or decrease of progress; thus, generating an opposition between EE and progress. However, Feenberg seems to adopt a concept of technological progress that escapes this dilemma and, therefore, his philosophy of technology can be of great interest in thinking about EE and its role in transforming the relationship between society and technology.

FEENBERG'S PHILOSOPHY AND THE QUESTION OF THECNOLOGY DEMOCRATIZATION

Feenberg develops the theme of the democratization of technology as part of a broad philosophical project. There are several aspects related to this topic present in his published texts. Yet, it is possible to make a selection that allows us to outline, in general terms, what is involved. This selection will be made considering the elements that will be important for our argument in this essay.

First, it is necessary to say that Feenberg treats technology as part of a type of game, in which there are political disputes; and this is part of what he calls "critical theory of technology" or – almost synonymously – "critical constructivism". According to Cruz (2020, p. 105), this approach is influenced by several authors, from theses developed by the Frankfurt School to philosophers such as Lukács and Heidegger. However, authors of social studies of science and technology also stand out, such as Bruno Latour, Michel Callon, Wiebe Bijker, Trevor Pinch, etc. This political aspect of technology, as proposed by Feenberg, is compatible with theses defended by Winner (2017).

Still according to Cruz (2020), Feenberg's purpose with the critical theory of technology is established as follows. His objective is:

> [...] to philosophically support the understanding that every technical solution, material (such as a machine) or immaterial (such as a procedure, an algorithm or a methodology), is never purely instrumental, but always incorporates other elements, such as ethical-political values. This is why the space of technological development is a political arena and must be disputed; and a dispute that, depending on its outcome, may imply a sociopolitical order that is closer or closer to the one we may be fighting for. (Cruz, 2020, p. 105-106).

What is being described points to two central theses to which Feenberg opposes. They are: (a) the thesis of *technological neutrality*; and (b) the thesis of *technological determinism*. Considering what has already been developed by Calazans and Martins (2021, p. 35-39) regarding these theses, it will be important to revisit some of their main concepts.

Regarding (a), it is possible to relate it to a perspective that became known as *the instrumental conception* of technology (cf. Feenberg, 2018). What it basically defends is that any technical solution constitutes a "pure instrument", as something that can be manipulated by humans so that they can achieve goals determined by themselves. More than simple manipulation, a notion of neutrality emerges, since it denies the existence of social elements (such as "ethical-political values") in that which constitutes, in itself, a technology. For this perspective, values are only associated with technology when it is used. An ethical evaluation of technology, for example, could not be made without considering the use and human intentions in question. An example given by Feenberg is the one regarding firearms. In the conception of the *National Rifle Association of America* (NRA), it is assumed that "Guns don't kill people, people kill people" (Feenberg, 2010, p. 36). For the author, this sentence is committed to a notion of neutrality regarding weapons, since it is only through effective human action that they can be associated with destructive values, whether to commit a crime or for self-defense. Before that, weapons are neutral instruments, and it is impossible to condemn them, in fact, since humans are the only ones responsible for the "evil" caused by them. In short, there is a need for human action to morally evaluate weapons, but

it is always the human decision to use the weapon that will be evaluated, without the very presence of the weapon in society becoming the center of moral reflection. The thesis of neutrality tends to question the *sphere of human action* more than *the existence* (the *Being*) of certain types of technologies, such as weapons.

Feenberg denies the instrumental perspective of technology. In his interpretation, technology (before use) already contains a social, ethical-political nature. Both aspects are part of the very constitution of technology. The use only highlights what is present there, even though technical functionality itself is one of the important aspects of the constitution of technology:

> Although critical theory of technology seeks **to identify social aspects of technology**, this approach **does not preclude recognition of the importance of simple functionality**. Technologies must really "work" to serve in social strategies, and **the one desideratum cannot be reduced to the other**. (Feenberg, 2010, p. 72, *Emphasis added*).

It is worth noting, in these words, that the critical theory of technology does not deny the importance of the "functionality" of technical solutions. Feenberg would be arguing against the classical thinking of *social constructivism of technology*, that seems to be a position sustained by some authors of the SCOT (*Social Construction of Technology*) movement, which includes Wiebe Bijker, Thomas Parke Hughes and Trevor Pinch (1989). Technical functionality would not be given central importance in the analysis of this group. It seems to be eclipsed by the effusive emphasis given, by these authors, to the role that social aspects play in the process of technological development. Thus, Feenberg states:

> [...] radical versions of constructivism are **wrong** to insist that **there is literally no distinction between the social and the technical**. If that were true, there would be no technical disciplines, and the makers and users of far simpler products would communicate more easily (Feenberg, 2010, p. 75, *Emphasis added*).

Therefore, unlike what a kind of radical constructivism of technology suggests, Feenberg admits the need to recognize that there are technical criteria in the given technical solutions that, however, are not neutral, since they are associated with social criteria.

Regarding thesis (b), the one about technological determinism, it is assumed that the driving force of history is technological advancement (Feenberg, 2018, p. 60). This is a thesis committed to technological development. Such development would be a process of technical evolution that would occur without receiving external influences, beyond the technical environment itself. However, controversy arises when it is assumed that such development would be capable of influencing social development. The opposite would be false. This is why the author states that determinism is based "on the assumption that technologies have an autonomous functional logic that can be explained without reference to society" (Feenberg, 2010, p. 8).

More specifically, this characterization of determinism presupposes two other theses. According to Feenberg (2010, p. 8-9), there is, (1) first, a commitment to a conception of *technological progress*; and (2) second, a way of interpreting the relationship between technology development and social institutions.

As for (1), the concept at stake is that there is an idea of necessity in technical development itself, that is, it would be a necessary departure from a “lower” level to a “higher” level of development. This means that, given a technical solution, its improvement presupposes that its higher stage must not only take into account what has already been given as a solution, but, in addition, must present itself as a kind of necessary substitute for what came before, being classified as a “better” solution than the previous stage. It is in this sense that, for Feenberg, it is assumed that technical progress would follow “a unilinear and fixed course”.

On the other hand, as for (2), technological determinism implies the adaptation of institutions to what is achieved in technical development. Feenberg himself (2010, p. 9) assumes that this thesis has its origins in some readings of Marx's texts. However, more than that, it is possible to say that such a critical interpretation by Feenberg presupposes something that is in harmony with that thesis of the instrumental conception of technology, that is, determinism adheres to the perspective of neutrality, as it is believed that technological development does not contain values, since it is guided by the internal criterion of “good” functionality. Thus, the only desirable value is the value that can be translated into the “form of technical efficiency” (Feenberg, 2010, p. 36). Such a concept is reduced to pure functionality, that is, to a good performance in solving a technical problem.

This way, a deterministic view emerges when it is assumed that efficient technical progress would shape society. In other words, social institutions must assimilate pure technical efficiency as the only value capable of producing development. What would be “good” for society comes from the criteria established in technical progress. The very concept of social development begins to be measured by what is present in technical development. This way, efficiency, in this restricted sense, becomes a value desired by society, which would determine the type of society to be built.

A questionable assumption of such a view concerns people's freedom of action. In the deterministic view, people cannot in fact choose, on the one hand, which technological aspect will actually be developed and, on the other, which values should be enhanced by technology in society. There is no freedom for people to direct social development independently of what is established in technological development.

Therefore, these are the problems that lead Feenberg to reject the deterministic approach to technology. In the opposite direction, his critical theory of technology argues that society can, in fact, direct technological development according to what it deems pertinent for social development.

Social interests voiced in political disputes do indeed interfere in the directions that technology can take. An example of this is the very concept of “technical efficiency” (cf. Feenberg, 2010, p. 19-21). In a capitalist society, this concept is translated in terms of productivity and profit-making. Political and economic interests, which are hegemonic in capitalist societies, can lead to the adoption of one type of technical solution and not another. Thus, for Feenberg, technological advancement is always driven by social interests, which implies, at the same time, on assuming the social values potentially embedded in the chosen solutions.

Technology is not neutral, and the social elements present in technical solutions intensify characteristics of the society in which they are present.

In addition to these assumptions, one way to show how technical and social aspects are present in technical solutions is through what Feenberg calls the theory of the *double instrumentalization* of technology. What is this? In short, it is a conceptual approach that aims to avoid interpreting technology based on the theses of neutrality and determinism, which are therefore committed to a *unilinear vision of technological progress*. More than that, the purpose is, above all, to reveal the way in which both the technical and social aspects of technology are harmonized or balanced:

> [...] critical theory of technology distinguishes analytically between the aspect of technology stemming from the functional relation to reality, which I call the "primary instrumentalization," and the aspect stemming from its social involvements and implementation, which I call the "secondary instrumentalization" (Feenberg, 2010, p. 72).

What is basically being proposed is that *primary instrumentalization* describes the technical aspects of the solutions developed. It addresses the functional elements in relation to the natural environment that a technology involves. On the other hand, *secondary instrumentalization* makes an effort to contextualize the technical solutions in the social environment, the objective of which is to identify the social aspects of the proposed solutions.

However, it should be noted that the two instrumentalizations are subject only to an analytical distinction – only a conceptual, theoretical, philosophical approach –, since, from a practical point of view, they effectively coexist in the proposed technical solutions.

Taking this as a premise, as Cruz (2020, p. 107-110) indicates, Feenberg (2002) processes the two instrumentalizations in four stages: *decontextualization and systematization; reductionism and mediation; autonomization and identity; positioning and initiative*. It is not needed to detail each of the stages here. However, the fundamental thing is that each stage is not constituted as a kind of chronological stage in the development of a technical solution. What we find in them is an effort, on Feenberg's part, to explain how technical and social elements are incorporated into the complex process of developing a technology.

In short, it is not enough for a technology to work for it to be socially accepted. Propositions for technical solutions can be developed (or not) to the extent that the social elements present there are compatible (or not) with the social interests in dispute, especially the interests of those who hegemonically exercise power (cf. Kirkpatirck, 2020; Cupani, 2016, p. 160). Therefore, double instrumentalization attempts to clarify how technological development occurs, situating it in the thesis that this is done under the mutual influence of social criteria and technical functioning.

Finally, it is necessary to state that the establishment of a critical theory of technology aims to reformulate the very concept of "rationality" traditionally involved in the process of technological development. Feenberg (2010, p. 7) attributes to Max Weber the thesis of the incompatibility between democracy and the scientific rationalization developed in modernity. For him, from the moment such rationalization is associated with calculation, this would translate, in social

life, as control. The development of capitalist societies, based on the model of scientific rationality, had social control as an effect. Feenberg refers to the "iron cage" – which is a possible translation of *stahlhartes Gehäuse*, as proposed by Weber (2004, p. 165) – to characterize this social control. Thus, where there is control, there is also a hierarchy between the one who controls and the one who is controlled. In turn, still from the perspective of what Weber proposes, a democracy would not be possible based on this hierarchical conception. Rationalization, control and hierarchy are terms that would seem contradictory to a democratic conception of society.

Given this scenario constructed from Weber's theses, it seems that one solution would be to adopt a conservative view, which would defend the establishment of a type of pre-industrial society. Another possibility is to assume that this conception of "rationality", as criticized by Weber, would only be possible to overcome by adopting a "romantic" conception, which would evoke irrational forces in the fight against authoritarian and hierarchical control. However, Feenberg rejects the very dichotomy between technological rationalization and democracy, something present in Weber's position. Thus, he adds, when commenting on the title *Democratic Rationalization* of chapter 1 of one of his books:

> My title is meant to reject the dichotomy between rational hierarchy and irrational protest implicit in Weber's position. If authoritarian social hierarchy is truly a contingent dimension of technical progress, as I believe, and not a technical necessity, then there must be an alternative rationalization of society that democratizes rather than centralizes control. We need not go underground or native to preserve threatened values such as freedom and individuality (Feenberg, 2010, p. 7).

Now, by proposing that technology has social aspects, Feenberg suggests that society itself can decide the direction taken by technological development. Technology's democratization is in line with the need for everyone involved in the process, both proponents and those who feel affected by technology, to have a voice and decision-making power. This is an attempt to attack the hierarchy present in the Weberian conception. Rationalization, now, would be democratic, in the sense of assuming itself as a solution that recognizes the elements of technical functionality, as predicted for in primary instrumentalization; but, in addition, it also recognizes that technology itself can be the result of social decisions. Social arrangements, guided by democracy, can allow for technical solutions that enhance democracy itself.

Let us consider the following statements by Feenberg:

> What does it mean to democratize technology? The problem is not primarily one of legal rights but of initiative and participation. Legal forms may eventually routinize claims that are asserted informally at first, but the forms will remain hollow unless they emerge from the experience and needs of individuals resisting a technocratic hegemony.
>
> That resistance takes many forms, from union struggles over health and safety in nuclear power plants to community struggles over toxic waste disposal to political demands for regulation of reproductive technologies. These movements alert us to the need to take technological externalities into account and demand design changes responsive to the enlarged context revealed in that accounting (Feenberg, 2010, p. 26).

In other words, Feenberg believes in the possibility of reconciling rationality and technology with democratic values. And the struggle carried out by social movements would be the best example of how, historically, the course of technological development has been altered, in the sense of illustrating how the democratization of technology would not be a concept devoid of meaning.

THE ENVIRONMENTAL QUESTION AND TECHNOLOGY'S DEMOCRATISATION IN FEENBERG'S PERSPECTIVE

Feenberg's thinking on the democratization of technology provides a consistent theoretical basis for addressing EE. However, although the author pays significant attention to the environmental issue, the specific theme of EE is not directly addressed. This does not mean that attempts to develop this theme using Andrew Feenberg's philosophy of technology as a theoretical basis are unfeasible. It simply means that this path will require some theoretical and conceptual work. Thus, before reaching the central theme, related to EE, let us consider the broader scope: technology's democratization, with regard to the environmental issue.

Feenberg (2002, p. 18) addresses the development dilemma as a difficult choice between virtue and prosperity. However, it is basically a view that technological progress is incompatible with environmental quality and, therefore, it would be necessary to choose between, on the one hand, slowing down progress to preserve the environment and, on the other, continuing with progress, bearing the disastrous environmental consequences. This dilemma, according to Feenberg, originates in the application of a principle of economics: *the theory of compensatory exchanges.*

Based on this theory, environmental regulation, for example, is made based on a cost-benefit analysis:

> For example, each incremental increase in the cleanliness of the air produces an incremental decrease in the number of respiratory illnesses. The policy choice is clarified by estimating the cost of tightening emission standards, then estimating the reduction in medical costs (Feenberg, 2010, p. 33).

This type of analysis undeniably has practical value. However, Feenberg wonders about the consequences of adopting the theory of compensatory exchanges in a broader scope of civilizing projects that involve environmental transformation. The author points to the philosophical commitments of this analysis, emphasizing that "trade-offs imply technological determinism and the neutrality of technology" (Feenberg, 2010, p. 34). This means that this exchange model is restricted to a single efficiency criterion, allowing only one choice between two paths: either the technical criterion is prioritized, which in this case is the most profitable; or the social value (security, for example) is chosen, regardless of profit. This is a deterministic way of thinking, since it does not consider other possibilities to define efficiency; and it is neutral, since it admits that social values would not interfere with technical efficiency, since they belong to an external sphere.

As seen in the previous section, these are two pillars of Feenberg's philosophy of technology: non-determinism and non-neutrality of technology. Thus, to the extent that assuming compensatory exchanges as a principle for technological and

environmental public policies means committing to the denial of the two pillars in question, it is essential for the author to present an alternative to this principle of economics.

The environmental movement – not exclusively, since the same occurs in other issues – highlights the practical implications of ideas that are apparently restricted to the theoretical field (determinism and neutrality). We hope to have shown in the previous section that, for Feenberg, the union between the deterministic conception of technology and the assumption of its neutrality leads to a unidirectional view of technological progress. In other words, there would be a single possible path of technological advancement and efficiency, in a capitalist context, would be the ultimate criterion for measuring this advancement. Since efficiency is directly related to profit, the scenario is divided into two opposing groups: on the one hand, the experts, capable of making efficiency calculations, and, on the other, the environmentalists who, in trying to impose their "ideological" objectives of environmental protection, advocate obstruction of progress.

These "ideological" goals thus have a social character, as opposed to the purely technical character of efficiency, seen from the perspective of unidirectional progress. In a general scheme, the design of a given technological object would be guided exclusively by technical criteria. However, social criteria would be imposed, most often in opposition to technical ones. For example, the car engine did not originally include devices to control pollutant emissions. However, environmental regulations imposed such devices, so the *design* had to adapt:

> Because technology is designed in abstraction from these so-called soft values, including them at a later stage has highly visible costs. These costs appear to represent essential trade-offs inscribed in the very nature of industrial society when in reality they are side effects of a reified design process. The design of the automobile engine, for example, is complicated by the addition of inelegant pollution control devices, such as catalytic converters. The design of cities is compromised, in turn, by attempts to adapt them to ever more automobiles, and so on. It would be easy to multiply such examples of the social construction of the dilemma of environmental values versus technical efficiency (Feenberg, 2002, p. 185-186).

It is important to note that the dilemma between these values is only properly characterized as a dilemma to the extent that the unidirectional conception of progress is assumed – and, consequently, the theses of determinism and the neutrality of technology. The technical aspects would be restricted to the functional scope of technological production, while the social aspects would provide the meaning, considered, mainly by specialists, as external to the function. However, Feenberg argues that the meaning is part of the constitution of the technological object, as much as its function, according to the *Double Aspect Theory*, defended by the author. In other words, for Feenberg, the functional description does not exhaust, in ontological terms, what a given technological solution is. The double aspect argues that the "social meaning and functional rationality are inextricably intertwined dimensions of technology. They are not ontologically distinct with meaning in the observer's mind and rationality in the technology proper" (Feenberg, 2010, p. 18). There would be no pure description, independently of social bias, as a result of the analysis of a "pure" rationality. The functional description, which seems decontextualized, because it is an attempt to isolate a technological object and adapt it to a "theoretical system", is made in

specific institutions: laboratories and research centers. However, these environments, which attempt to decontextualize technological objects, are institutions, themselves impregnated with social values, because they are the result of social disputes, of powers. It is not possible to say that such institutions are socially "neutral", since they are the result of what society itself adopts as values to be followed.

Thus, the unidirectional conception of progress leads to the misconception that there is a single criterion for determining technological advancement – the efficiency – since it reduces the issue to the technical aspect, which can be translated into terms of calculable costs and benefits. However, is it possible to calculate the price of all human values? Feenberg evokes the example of Central Park in New York. Is there any calculation in the real estate sector that could stipulate the value of this "land"? The answer is no, because what is at stake concerns meaning and not simply function. This is a first limit to the use of economic calculation regarding technology and the environment.

Furthermore, environmental regulation, for example, which initially appears to hinder progress, can later lead to unexpected developments. Here, the author recalls the case of the automobile industry, which, in response to the pollution control legislation, had to reduce fuel efficiency. This was an undesirable trade-off. However, this restriction led to the development of the electronic injection, thus reconciling the two aspects: pollution control and fuel efficiency. In this example, linear and deterministic thinking would lead to avoiding the first trade-off at all costs, since, by considering a single path of progress, it would not consider possible further development, led by an alternative path.

So, in retrospect, the development of the electronic injection depended on both technical criteria and the values implied in the notion of the meaning of technology. These values are not unanimously expressed by society, and were not even accepted by the group most interested in the development of the sector. What is noteworthy is that one group – especially interested in environmental issues – democratically made its values prevail, to the point of generating pollution control legislation. In other words, the dispute between different values is as much a part of technological development as the tension between technical criteria and social criteria. Feenberg states:

> The polluter is less likely to see the relevance of environmental ethics to technology than the victim of pollution. And so on. Thus, what essentialism conceives as an ontological split between technology and meaning, I conceive as a terrain of struggle between different types of actors differently engaged with technology and meaning (Feenberg, 1999, p. xiii).

In this sense, environmental issues are central to the process of democratizing technology:

> Too often technology and culture are reified and opposed to each other in arguments about the "trade-offs" between efficiency and substantive goals such as participation or environmental compatibility. A better understanding of the relation of technology and culture dissolves these apparent contradictions. […] The conclusion develops this argument further through a holistic critique of technology and a theory of its democratic potentialities. Although suppressed today, in the future these potentialities may become the basis for a society that reconciles wider freedoms with more meaningful forms of material well-being (Feenberg, 2002, p. ix).

Different groups, from different cultures, also have different values, shared by their members. It is within these particular cultures that the different ways of conceiving the efficiency criterion are established. Contrary to what the deterministic view prescribes, efficiency is not a universal criterion, capable of establishing the unshakable parameters of development. And, since efficiency can be established differently, according to the values of the different groups in question, this criterion does not necessarily need to be contrary to environmental preservation:

> Efficiency is not the enemy even from an environmental point of view. A better society need not be inefficient and poor. That position concedes too much to the dominant ideology. Means-ends rationality is no doubt an unsurpassable dimension of modernity, but it will have quite different results in cultures that measure success differently, define the legitimate domain of optimization differently, and have different ends in view. There thus is no reason of principle why one would have to retreat economically in order to achieve ecological and democratic objectives (Feenberg, 2002, p. 142).

By fostering democratic exchange with cultures capable of understanding the criterion of efficiency in a way that is different from the economists' reduction to what is quantifiable, humanity can benefit from more balanced and beneficial relationships between the economy and environmental protection. To achieve this, it is necessary for culture, taken in a broad sense, to assimilate these other values, in order to reintegrate the meaning of resources that – following the logic of cost-benefit – are reduced to the category of "goods". So, how would it be possible to achieve this reintegration? Would environmental education be an alternative?

Feenberg understands education as an emancipatory process. The goal of this process, considered in this way, should include the training of individuals not only to understand, but mainly to transform the relationships between technology, society and the environment. In addition to purely informative objectives, education should promote critical development, as a trigger for a transformative movement: the critical engagement that results from this process provides the conditions for students to question the power dynamics that sustain current technological practices and, as a consequence, imagine more fair, democratic and ecological alternatives.

It is precisely in this transition between "understanding" and "transforming" that the philosophy of technology finds its role in interdisciplinary dialogue. Feenberg proposes that it is necessary to change the "technical code," understood as the set of standards and values that regulate technical work. In other words, the transformation that an EE would aim to promote involves understanding the current technical code – including the underlying social and political values – and democratic mobilization for commitment to other values and, consequently, to another technical code. Feenberg explains this dynamic by establishing a parallel with Thomas Kuhn's concept of paradigm. In the next and final section of the text, we will address this topic, with the purpose of extracting some theoretical bases for an EE compatible with Andrew Feenberg's philosophy of technology.

ENVIRONMENTAL EDUCATION, INTERDISCIPLINARITY AND THE REWRITING OF TECHNICAL CODES

The analogy between technical codes and Kuhnian paradigms has – as with all analogies – major points of convergence and also certain limits. We begin this section of the text by exploring such similarities and limits, in an attempt to highlight the central elements for a democratic environmental education, as proposed by Feenberg.

Cruz (2017, Note 2, p. 39-40) states that technical codes are the technological equivalent of scientific paradigms, as described by Kuhn. In the context of the development of science, Kuhn (2017) presents the concept of paradigm in several of its aspects. This has resulted in much criticism regarding the difficulties in precisely defining what a paradigm is in science. Regardless of these difficulties, what is at issue, and what is important to emphasize for our interests here, is that the paradigm concerns all the elements that condition the "world view" of a scientific community, that is, they condition the way in which it conceives what is relevant (problems, methodological rules, objects of study, equipment, etc.) for scientific activity. There is a period in which this occurs, called by Kuhn the period of *normal science*. In science, the *revolution* would be the total rupture with a paradigm and, consequently, the adoption of another one.

In turn, in the context of Feenberg's proposal, this means that technical codes act as paradigms; that is, just as the paradigm determines what is necessary for the stability of the period of normal science, such codes determine the elements necessary for an artifact (or technical solution) to be stabilized. In the case of technology, there are two fronts: the technical code, through well-defined rules, standardizes the functionalities considered essential (technical criteria) and establishes the underlying values (social criteria), in order to preserve the code from any change that could subvert it.

Again, like the paradigm, in the period of normal science, the technical code does not only establish the accepted functionalities for that artifact, but also the "world view" that organizes the criteria, including social ones, involved. In other words, there is no neutral, universal code, independent of specific ideologies and values. On the contrary, each technical code is established in accordance with values shared by a certain group that has an interest in the development of that artifact. The stabilizing role of the technical code – as well as of the paradigm – is exercised in the form of a certain resistance to any change that threatens the beliefs that structure the code.

However, the technical code may be challenged, as in the case of environmentalists, regarding the pollution impact of a given artifact, for example. Likewise, subversive uses may arise – when an artifact is used in a way other than intended – and challenge the stability of the beliefs shared by those who follow the technical code. In these circumstances, it will be necessary to incorporate new meanings (challenges) or new uses (subversive uses), which implies a radical change, since the technical code encompasses the set of beliefs in its entirety.

Cruz himself considers a scenario in which the technical code of agricultural techniques, for example, has assumed the values of productivity, submission to nature and profit in a hegemonic manner (as would be the case in a scientific

paradigm, which requires the unanimity of the scientific community). Values that are somehow considered not in line with the main values become peripheral, less important. In the same example, values such as environmental sustainability, popular empowerment and non-concentration of income will be relativized. In practice, consequences that do not relate to the main values – productivity, profit – will be minimized: the environmental impact and even impact on communities are considered less important losses.

So, how can this situation be changed? How can a technical code be rewritten? There are historical cases of rewriting technical codes in which the values associated with efficiency, understood in the sense of productivity and profit, were overcome by values such as safety and well-being. Feenberg (2010, p. 38-41) presents two great examples: the development of boilers, based on safety, in the United States and the ban on child labor in England. However, for this to occur, it was necessary to challenge the hegemony of previously assumed values, through a democratic and sufficiently organized movement, to the point of imposing alternative values, articulated in the public sphere. Only with the emergence of new values could new technical solutions also be considered. According to Feenberg (2010, p. 37), this constitutes a "democratic technological revolution".

At this point, we can turn our attention to the limits of the analogy with Kuhnian paradigms. In the case of science, revolution depends on a change in the beliefs assumed by the scientific community. Note that this is a restricted, closed group that has the autonomy to follow the dynamics of "The Structure of Scientific Revolutions" (paraphrasing the title of Thomas Kuhn's famous work), independently, or almost independently, of society, taken in a broader sense. If we can use the term "hegemony" in this context, it refers only to the unanimity achieved within the scientific community. When social values such as persuasion are mentioned, for example, the scope of these values is restricted to this same framework.

The case of technical codes is quite different. The democratic technological revolution, described by Feenberg, does not depend solely on a "technology community" (corresponding to Kuhn's scientific community), but on society, taken in a broad sense. The values in question, both the initially hegemonic and the alternative ones, are culturally assumed by groups that share certain interests and are not necessarily experts in the development of technological artifacts. We have reached an important point in our reflection: the democratic character of the technological revolution can only be inserted in the political clash between different groups, that is, the public sphere articulates new values that go beyond the scope of experts. This difference impacts the role that EE should play in technological issues.

On *Questioning Technology*, Feenberg states the following: "the most important means of assuring more democratic technical representation remains **transformation of the technical codes** and **the educational process** through which they are inculcated" (Feenberg, 1999, p. 143 *Emphasis added*). Therefore, if the educational process is responsible for inculcating technical codes, any prospect of establishing a technological revolution must consider this educational process. This is because, unlike scientific paradigms – whose hegemony is established within the restricted scope of the scientific community –, technical codes depend on values shared by culture, taken in a broad sense, in a given society. Thus, when dealing

with environmental technical codes, EE – understood not only in the school context, but in a broad sense – plays a central role in transforming the reductionist view of technological development. It can modify such codes, in the sense of including in society the search for technological solutions that enhance environmental values, harmonized with democracy and the plurality of forms of life.

Precisely at the limit of the analogy between paradigm and technical code, we are faced with a challenge for the educational process. The incommensurability between paradigms, addressed by Kuhn (2017), does not only affect chronologically subsequent paradigms of the same discipline. Likewise, two contemporary disciplines each have their own paradigm and they are incommensurable (cf. Barra, 2011). Therefore, the disciplinary educational process does not reach the broader scope necessary for technological and, consequently, environmental issues.

The radical change in the set of beliefs adopted by the scientific community, in the case of the reform of the technical code, must affect the culture, taken in its most general scope, that is, it must reach society itself. School education, through disciplines, communicates to the general public the beliefs shared by the respective paradigms, although, in general, there is a certain delay for the new beliefs, adopted by the scientific community, to reach the schools. In any case, it is the educational process that organizes the worldview, according to the beliefs of each paradigm. However, since the (disciplinary) paradigms are incommensurable with each other, in order to reach the general culture, in a scope broader than the disciplinary one, an interdisciplinary dialogue is necessary.

To address this issue of dialogue, it is worth following the change made by Kuhn himself. In the most mature phase of his philosophy, he replaced the concept of “paradigm” with the concept of “lexicon”. In the article entitled “Commensurability, comparability, communicability”, published in the collection *The road since structure*, Kuhn (2006) addresses the concept of incommensurability in terms of translation and interpretation between lexicons. By committing to a certain “semantic holism”, Kuhn highlights the role of the lexicon as an organizer of the worldview accepted by the community that shares such lexicon.

Regarding interdisciplinary dialogue, it would therefore be the purpose of *translating from one lexicon to another* (from one discipline to another) – without disregarding the interpretative nature of this translation –, producing an interaction between supporters of different worldviews who, together, intend to address the same issue; in this case, the environmental issue. This is the first level of dialogue. It is important to emphasize that, in addition to interdisciplinary dialogue, “transdisciplinarity” not only establishes this communication, but also allows us to think about how one discipline can interfere with the epistemological foundations of another. However, for the purposes of this theoretical essay, it is not appropriate to develop this point here.

In the context of technology, there is an articulation – even if it were possible to remain within the scope of technical criteria – of knowledge from various scientific disciplines, which, considering our disciplinary school model, would already require an interdisciplinary dialogue to be considered. Furthermore, what

Feenberg proposes, with regard to technical codes, is that not only technical criteria be considered, but also social criteria that impact technological development.

If the first level of interdisciplinary dialogue can remain within the epistemological sphere – insofar as the purpose is to know –, the technological revolution, including that linked to environmentalism, demands a political dialogue that reaches the axiological field (of values and foundations of action). As in the case of science, it is a revolution: "With environmentalism we are again witnessing the opening of a new path. Although its progress is slow and there are setbacks, environmentalism has the temporality of a revolution" (Feenberg, 2010, p. 45).

However, this revolution – or, rewriting of the technical code – goes beyond the scope of knowledge.

> In every case, a technical code describes the congruence of a social demand and a technical specification. It is generally materialized in two different ontological registers: discursive and technical. A process of translation links the two. For example, demand for greater attention to automotive safety is translated into seat belts and air bags; operationally speaking, these functionalizations are what safety *means*. Thus, technology and society are not alien realms as are facts and values in the treatises of philosophers. Rather they communicate constantly through the realization of values in design and the impact of design on values (Feenberg, 2010, p. 68).

With the rapid worsening of environmental problems currently being experienced, Feenberg states that it will become increasingly difficult to justify the current hegemonic values of profit and productivity, since the consequences of this thinking, shared by economically dominant groups, are increasingly evidently catastrophic, in the sense that they threaten the survival of our species. However, the author argues that combating this worsening does not need to – and should not – be done in the sense of giving up supposed progress in favor of environmental protection. This would mean proposing a solution that preserves the structure that created the problem. On the contrary, the rewriting of the technical code commits to another notion of progress, not unidirectional, in which the very criteria of efficiency and technological progress are redefined, due to the revolutionary nature of the process.

Something similar happened with traffic safety issues, for example. Nowadays, no one would dare to propose a financial calculation to question the cost-benefit of installing seat belts in cars, since the lives they save are not economically quantifiable. However, it was not always like this. A revolution was needed, a rewriting of the previous technical code, which radically changed – and with no chance of being reversed – the way in which the issue was considered.

According to Feenberg:

> From this standpoint, it seems likely that the ideological form of environmental values is temporary. These values will be incorporated into technical disciplines and codes in a technological revolution we are living unawares today. Environmentalism will not impoverish our society. We will go on enriching ourselves, but our definition of prosperity and the technologies instrumental to it will change and become more rational in the future judgment of our descendants. They will accept environmentalism as a self-evident advance. Just as images of Dickens in the bootblack factory testify to the backwardness of his society, so will images of asthmatic children in smog-ridden cities appear to those who come after us (Feenberg, 2010, p. 43).

If we aim to rewrite the current technical code regarding environmental issues, it will be necessary to promote what we call here *democratic environmental education*, which goes beyond the scope of educational institutions. This means that, based on what has been developed, it is possible to build an EE that assumes the "democratization of technology," as Feenberg proposes, as a fundamental point. More than that, such EE must be capable of incorporating into the culture alternative values to those of productivity and profit, which represent the current hegemony, without renouncing the possibility of social problems being addressed by technological solutions. For how else could we change the definition of prosperity and, consequently, translate this change into other instrumental technologies? Technological literacy, promoted in the educational process, must be critical, that is, it must enable individuals not only to *interpret* technological systems. Education must enable individuals to *transform* the technical solutions adopted in order to strengthen democratic values. This implies modifications of existing solutions, or the replacement and adoption of solutions that are radically different from those already in place. This involves not only understanding how technologies work, but also recognizing their political, environmental and social impacts.

In other words, technological literacy cannot be restricted to one or another discipline, nor can it be limited to the epistemological aspects of teaching. It is necessary to promote interdisciplinary dialogue, including with disciplines in the humanities group, with the purpose of offering the conceptual tools essential for a critical, and therefore philosophical, self-understanding of the role that students are capable of playing in political debate (based on democracy) not only in the distant future, but also as a student movement.

In *Questioning Technology*, Feenberg uses a historical example: the student movement of the 1960s in France and the revolt against technocracy:

> But if technocratic ideology is not altogether true, it is plausible enough and believed enough to change the image of the university, that breeding ground of technical competence. In the late 1960s, student resistance was directed at first against the growing pressure to achieve a technocratic integration of the university and society.3 In France a profoundly traditional university viewed the rise of technocracy with dismay and resisted adaptation to a world it rejected. In America the movement arose simultaneously with the creation of the modern "multiversity," in the service of business and government as never before.
>
> Mass education certainly made for a less agreeable and prestigious college experience. However, the movements of the 1960s were not merely reactions to the declining quality of student life. Still more important was the students' relation to society in general and their perception of the university as a social institution (Feenberg, 1999, p. 22-23).

This direct participation of the student movement in the fight against the technocratic system, which they saw as a centralizing and alienating regime, based on technical and administrative values to the detriment of human and democratic values, can be thought of as a collaboration in the rewriting of a technical code, that is, a democratic technological revolution. This transformation of bureaucratic institutions, desired by the movement, could only be structured to the extent that the students were able to give up a conception of technological neutrality. The student revolt became an opportunity to redefine the priorities of modern societies, placing technology at the service of democracy and human well-being.

Despite being a non-hegemonic, even marginalized group, the student movement involved in the revolt managed to challenge technocratic hegemony and propose more democratic alternatives. From Feenberg's perspective, this event illustrates the non-determinism and non-neutrality of technology, which, far from being an unalterable force, is subject to the influence of social groups. Considering universities as a microcosm of hegemonic technocratic control, this case can be taken as a particular example of the power that the educational process can confer on individuals, regarding the articulation, in the public sphere, of alternative values to those currently in force.

CONCLUSION

The philosophy of technology proposed by Feenberg is incompatible with the view that a technical solution should be adopted solely because it is efficient, based on an exclusively functional judgment. In other words, it is incompatible with the thesis that technological development is assumed to be an autonomous (self-determined), neutral and unidirectional process. Every technological solution is imbued with social values. In a society that claims to be democratic, the debate around which values will be reinforced by the adoption of a technology is fundamental, since antidemocratic values may underlie the technological solution in question.

Regarding EE, if its purpose is to promote changes in hegemonic technical codes that are harmful to the environment, one of the main conclusions of this essay is that it is possible to think about harmonizing technological development with the demands arising from environmental issues. There are arguments in Feenberg's philosophy that lead to the possibility of formulating a conception of EE that is open to technical progress, however, without renouncing what would be most important to it, namely, the need to build a non-destructive relationship (for both sides) between society and the environment. This involves recognizing the political attitude present there. However, there is no possibility of this being achieved without the process of democratization of technology also being the focus of attention. Ultimately, EE itself becomes, from Feenberg's perspective, another important path to advance this democratization project.

Furthermore, it is concluded that in this interdisciplinary process, towards changing the technical code, it is necessary to consider two fundamental stages: *knowing* and *transforming*.

Environmental issues articulate knowledge that goes beyond the disciplinary scope. Environmental education must therefore promote interdisciplinary dialogue, capable of providing the epistemological tools to gain in-depth knowledge of the problems related to the impacts (negative and positive) of environmental technological solutions. This point may perhaps seem obvious. However, the novelty that can be extracted from Feenberg's philosophy of technology is that, in order to be democratic, environmental education cannot be restricted to technical and functional aspects. It must also be dedicated to investigating and enabling people to reflect on the social values that permeate, in an ontological sense, the technical aspects mentioned.

Thus, the desired *transformation*, regarding environmental issues, will not come about solely through knowledge of the hegemonically established technical codes. The political mobilization of groups interested in confronting such hegemony is necessary. Here is another contribution of Feenberg's philosophy: an emancipatory EE presupposes, in an interdisciplinary way – since it is a dialogue between different lexicons –, technical and social (ethical and political) literacy.

NOTES

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