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Sustainability And Transdisciplinarity In Vocacional And Technological Education (VTE): An Analysis From The Perspective Of Profept Master Students

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Abstract

In a historical moment of complexity paradigm, and as a way to expand the debate on such close subjects, this article aimed to analyze and reflect on sustainability and transdisciplinarity in Vocational and Technological Education (VTE) from the perspective of the students of the ProfEPT professional master's degree. The data collection methodology was documentary and exploratory, from 2020 to 2022, in four classes of the discipline "Special Topics: Sustainability as a practice for transdisciplinarity in VTE", taught by the Federal Institute of Paraná. We discussed the results using the content analysis technique, where ten categories of data were found, all correlated with each other. In general, it was registered that the content of the analyzed discipline assisted with the dissertation, pedagogical practice and adoption of personal practices, in addition to being highlighted as a positive experience of knowledge Exchange among students. Therefore, we identified levels of transdisciplinary, individual and collective processes and connections, through the presented didactic sequence, as well as the importance of continued teacher education being evidence.

Keywords: environmental education; teacher training; active methodologies.

1. Introduction

The world changed. This obvious observation is recurrent in speech from previous to contemporary generations since the mid-1800s. In fact, in the last 200 years, the way of life of the population in several countries has been profoundly changed due to new discoveries in science and advances in technology. Most notably, from 2020 to 2022, the covid-19 pandemic accelerated innovations and exposed inequalities, exclusions and vulnerabilities, showing the urgent need to change the capitalist, colonialist and patriarchal pattern (Laranja and Pinto, 2022) .

In view of this, in the midst of the 21st century, it was realized that "development" needs an adjective, even though it seems paradoxical to add "sustainable" to it. In this new paradigm of complexity, there is an increasingly broad consensus that sustainability is the basis for preserving the planet and species (Leach et al., 2021). Sustainability is understood as the form of production that leads to sustainable development [1] . Therefore, sustainability must have a holistic, systemic, ecocentric and biocentric definition (Boff, 2014).

In this way, Elkington (2012, p. 101) materialized sustainability into three main primary pillars (environmental, social and economic) based on the observation of "[...] growing imbalance of the main factors of production – land, work and capital ". In this way, it is possible to aim for sustainable development, defined by the Brundtland Report, as one that, in the present, does not compromise meeting the needs of future generations (Japiassu and Guerra, 2017).

Expanding the concept of sustainability, Lopes and Tenório (2011) added two new pillars as important supports for sustainable development: education and ethics. Although they may seem to belong to the social pillar, the two new pillars refer to the subject, to individual consciousness. The authors realize that "education and ethics are linked to the creation of individual habits, for the

subject's decision-making, so that there is effective integration into society, the community or organizational and social environment" (Lopes and Tenório , 2011, p. 96).

That said, it is not necessary to reflect much to conclude that sustainability is a human right, despite not being explicit in the Universal Declaration of Human Rights (UDHR), written in 1948 (Nações Unidas Brasil, 2020), as it is currently understood that sustainability encompasses several ideals present in the document and other treaties. Words with strong meaning, such as freedom, justice and peace, are common in the UDHR and the 17 Sustainable Development Goals (SDGs), proving their close relationships.

The SDGs, the set of which can also be called the 2030 Agenda, have 169 bold goals (United Nations, 2023), which, in order to be fulfilled, need to be disseminated to the largest number of interested parties, such as municipal, state and federal institutions; control institutions; and financing institutions.

Another very powerful way of disseminating the SDGs, which at the same time is part of the concept of sustainability, is through education, at all levels . In this way, sustainability is fed back by education: the more the subject studies, the more sensitive they become to the interconnections of sustainability and, thus, through acts and words, actions and omissions, they propagate the importance of sustainability and education.

In this sense, as part of the broader educational process, special attention must be given to environmental education (EE), not as an isolated subject, but integrated into educational programs (Brasil, 1999). The National Environmental Education Policy (Law n. 9795/99) has as one of the objectives of EA is "the development of an integrated understanding of the environment in its multiple and complex

relationships, involving ecological, psychological, legal, political, social aspects , economic, scientific, cultural and ethical" (Brazil, 1999 , p. 2).

It is worth mentioning that EA can have other names, such as education for sustainable development (EDS) (Kioupie and Voulvoulis, 2019) and education for sustainability (EpS) (Lopes and Tenório, 2011). In fact, if correctly applied, they all follow the same line: they are holistic, systemic and critical, where the causes and consequences of global problems are interrelated, and their dimensions cannot be dealt with individually (Loureiro & Layrargues, 2013). In addition to ecological aspects, there must be the inclusion of cross-cutting issues pertinent to sustainability, such as inequality, democracy, justice, culture and globalization in the capitalist and environmental pattern (Lopes and Tenório, 2011).

Sustainability itself encompasses several "disciplines", and the interaction of these disciplines must come into the equation. Erich Jantsch and Guy Michaud began this discussion in the 1970s (Jantsch and Michaud, 1972), and Hilton Japiassu brought it to Brazil with adaptations, organizing levels of complexity of these relationships: multidisciplinary, pluridisciplinary, interdisciplinary and transdisciplinary (Japiassu, 1976). At the highest level, trans can be defined as "that which is at once between disciplines, across different disciplines and beyond any discipline" (Nicolescu, 1999, p. 51).

Despite the vast theoretical framework on the subjects, the academic discussion on sustainability and transdisciplinarity in professional and technological education (EPT) is still very timid, with gaps in its full understanding and correct application. This may occur because in EPT the dimensions of work, science and technology are privileged (Brasil, 2008).

It is known that EPT, in Brazil, covers initial and continuing training courses (FIC), secondary-level technical courses, undergraduate and postgraduate courses (Brasil, 2008). In this context, the Federal Institutes of Education, Science and Technology (IFs) offer EPT courses in their various forms.

In this direction, with the "need to improve educational practices and school management linked to EPT, in conjunction with the demand for professional qualifications [...]" (Ministry of Education, 2019, p. 5), the Professional Master's Program in Professional Education on a National Network (ProfEPT) was created in 2016. The ProfEPT organization is linked to the Federal Institute of Espírito Santo (IFES) and is made up of a Management Committee, which coordinates a Commission National Academic Committee, which in turn coordinates the Local Academic Committees, constituted in each of the 38 Associated Institutions (IA). In Paraná, the IA is the Federal Institute of Paraná (IFPR). Currently, ProfEPT has 528 teachers and, in 2022 alone, 864 students were admitted, according to the ProfEPT Observatory (Ministry of Education, 2022). According to the portal, since 2018, ProfEPT has had 1,146 graduates.

ProfEPT is part of the Teaching area and the large Multidisciplinary area of CAPES, and has two lines of research: "Organization and Memories of Pedagogical Spaces in EPT" and "Educational Practices in EPT". The program is structured with 5 mandatory subjects, 3 research-oriented subjects, and 13 elective subjects. Of all these disciplines, only one deals, indirectly, with sustainability: "Science, Technology, Society and Environment". To remedy some gaps, among the elective subjects, there is a provision for Special Topics (TE), which are syllabuses proposed by teachers according to their performance and interest. From 2018 to the present date, 24 TE disciplines have been proposed, only one of which

is specific to EpS and addresses two important dimensions for a new education: "Sustainability as a practice for transdisciplinarity in EPT".

Due to the intricate context presented, taking into account that education plays a fundamental role in the processes of establishing citizenship, the research problem that guided this article was: how sustainability could be worked on in EPT to guarantee the transdisciplinary training of teachers so that these two dimensions can be disseminated as widely as possible?

This is a question with multiple answers, as sustainability accepts different perspectives and different approaches, as well as transdisciplinarity. In view of this, as a possible contribution, the objective of this article was to analyze and reflect on sustainability and transdisciplinarity in Professional and Technological Education (EPT) from the perspective of students of the ProfEPT professional master's degree.

It is understood that this is a possibility because working on EpS in a professional master's program means starting the discussion at the top of the pyramid, which will branch out to other levels of education through trained professionals when they work in their respective work environments. .

2. **Methodology**

This investigation has a qualitative, exploratory and documentary approach of an interpretative nature (Gil, 2011).

The research was carried out in four classes of the discipline "Special Topics: Sustainability as a practice for transdisciplinarity in EPT", taught in the "Distance Education" (EaD) modality by IA from IFPR, in Curitiba, in the ProfEPT master's degree. The subject is anchored in the IFES virtual learning environment and the material is organized using the Moodle software .

This subject is taught every semester, with a course load of ٣٠ hours. The didactic sequence was developed in 10 weekly meetings and the content of each topic was evaluated by the students using the "Forum" tool. At the end of the period, students were also invited to evaluate the entire subject.

The data was collected from 2020 to 2022 from the evaluations of 34 students from 19 AIs and analyzed from the perspective of Bardin (2011). The content analysis (CA) technique is composed of three phases: i) pre-analysis (floating reading); ii) exploration of the material (coding and categorization of data), and iii) treatment of results (interpretation and discussions) (Bardin, 2011).

2.1 Didactic sequence

For Zabala (2010, p.18) , a didactic sequence (SD) is "a set of ordered, structured and articulated activities to achieve certain educational objectives, which have a beginning and an end known to both teachers and students" .

The objectives of the subject analyzed were for master's students: i) to have an overview of environmental problems at a global level, their causes and consequences; ii) recognize the importance of environmental education in formal and non-formal spaces for sustainable development; iii) know and understand the use of environmental indicators as tools for environmental education; and iv) know, understand and apply active methodologies for a new education.

The teaching procedures were: provision of recorded classes, videos from the YouTube platform, articles and support material. This material formed the basic, non-exclusive, research framework for the development of student activities.

Students should maintain contact in the discussion forum, watch the videos available, download and read the written material, send questions through the

discipline's virtual environment, share experiences of their pedagogical practices with the class, and carry out assessment activities weekly.

Assessments were carried out continuously and cumulatively, with qualitative aspects predominating over quantitative aspects, with student development throughout the course taking precedence. To achieve the proposed objectives, the learning assessment was focused on the performance of individual activities. The instruments used for assessment were: responses to questionnaires, interpretations of articles, debate in discussion forums, recording and presentation of videos (seminar), peer assessment, subject assessment and self-assessment. As a teaching resource, deadlines for completing the activities were inserted into the platform.

The study recovery regime as part of the teaching and learning process was carried out in parallel, and consisted of individualized assistance via chat on the virtual platform or by email.

In the following sections, the didactic sequence of the curricular unit will be presented with the content of each week, the methodologies adopted, suggestions for additional study and proposed assessments. Didactically, Weeks 1 to 6 present themes on sustainability, and Weeks 7 to 10 provide theoretical and pedagogical support for educational practices. It was therefore intended that the intersection of each week would result in knowledge for the master's student and that, when subsequently applied and transmitted, it would provide significant and transversal learning to students at any level of EPT.

Week 1. Sustainability Concepts: emergence of the planet and evolution of the biosphere

In that first week, an explanatory video of the teaching plan, recorded by the teacher, was posted in the discipline's virtual environment, explaining how the

studies would be guided, how the weeks would unfold and the activities that could be proposed. A communication channel was also opened in case any student had difficulty accessing materials or posting activities.

To start raising awareness about sustainability, we thought of carrying out a historical review since the emergence of the Earth, the creation of life and the evolution of the biosphere. In an interconnected way, it was also intended to show how all human beings are connected to each other and to the planet.

Therefore, as study content for this week, we were asked to read pages 107 to 117 of chapter 3.6 of the e-book Environmental calendar and [...] active methodologies: proposal for a new education, authored by the teacher. Another explanatory video recorded by the teacher on the subject was also posted, complementing and summarizing the information in the text.

As complementary material, the following study suggestions were posted, a book and four documentaries, as can be seen in Table 1.

Table 1. Complementary material such as study suggestions for Week 1

Title of material	Type of material
Odum, Eugene. (2012). Ecology. Guanabara Koogan.	Book
Jones, Dan. (2009). Charles Darwin and the Tree of Life. Presentation: David Attenborough. British Broadcast Corporation (BBC); Discovery Channel. 59 min, color.	Documentary
Dockstader, Noel. (2005). Guns, Germs and Steel. Production: National Geographic. Distribution: Log On.	Documentary

166 min, color.	
Dockstader, Noel. (2005). Collapse. Production: National Geographic. Distribution: Log On. 96 min, color.	Documentary
Borges, Celia. (2007). What is environment. 13 min., color.	Documentary

Source: the author.

As evaluative activities, the following were requested: 1) prepare a mental map about the evolution of the biosphere; 2) watch the video The DNA Journey, from Momondo [2] ; 3) insert personal comments about the experience when watching the video; 4) correlate the video with content about the evolution of the biosphere; 5) evaluate pedagogical aspects of the week in the virtual platform forum.

Week 2. Sustainability concepts: classical ecology x deep ecology

In the second week, the intention was to bring to light some theoretical aspects about the development of systemic thinking in ecology.

Therefore, two texts were requested to be read: i) The eight principles of deep ecology, article by José Eustáquio Diniz Alves; and ii) Deep ecology, article by Roberto Naime.

To raise awareness on the topic, the revealing documentary O Poem Imperfeito, by Zulmira Coimbra [3] , was posted about the book of the same name by Fernando Fernandez. This video exposes a profound evolutionary relationship between human beings and other living beings, and “how the unbridled economic growth of human overpopulation on a planet with finite resources implies the loss of biodiversity, ecological services and the quality of life of its inhabitants – both human and non-human” (Coimbra, 2018).

As complementary material for study, nine book suggestions and a documentary were posted (Table 2).

Table 2. Complementary material such as study suggestions for Week 2

Title of material	Type of material
Lovelock, James. (2006). Gaia: cure for a sick planet. Cultrix.	Book
Lovelock, James. (2011). A new look at life on Earth. Editions 70.	Book
Lovelock, James (2006). Gaia's revenge. Intrinsic.	Book
Ferrero, Elisabeth M.; & Holland, Joe. (2004). Earth Charter: reflection through action. Cortez; Paulo Freire Institute.	Book
Boff, Leonardo. (2012). The four ecologies: environmental, political and social, cultural and integral. Sea of Ideas.	Book
Hathaway, Mark; & Boff, Leonardo. (2012). The Tao of Liberation: Exploring the Ecology of Liberation. Voices.	Book
Capra, Fritjof. (2001). The web of life. 6 ed. Cultrix.	Book
Capra, Fritjof. (2003). The hidden connections. Cultrix.	Book
Fernandez, Fernando. (2004). The imperfect poem: chronicles of biology, nature conservation and their	Book

heroes . 3rd ed. UFPR publisher.	
Guggenheim, Davis. (2006). An inconvenient truth. Narration: Al Gore. Paramount Pictures. 94 min, color.	Documentary

Source: the author.

This week's evaluation activities were: 1) after reading the texts selected for the week, use the virtual environment's forum to write considerations on the subject and/or respond to colleagues' considerations; 2) after watching the documentary O Poem Imperfeito, prepare a critical review of the film; 3) evaluate pedagogical aspects of the week in the virtual platform forum.

Week 3. Sustainability concepts: Sustainable Development Goals (SDGs)

This week's purpose was to present the Sustainable Development Goals (SDGs), the basis of global planning until 2030. For a holistic understanding of the topic, audiences were asked to watch the impactful documentary The Light Bulb Conspiracy, produced by Cosima Dannoritzer (2010). This controversial work denounces the social and environmental cruelty of capitalism.

Careful reading of the Earth Charter and exploration of the UN website on the SDGs were also requested.

This week's suggestions for additional study include a book, a medium-length film, six short films and an internet video platform channel, as shown in Table 3.

Table 3. Complementary material such as study suggestions for Week 3

Title of material	Type of material

Boff, Leonardo. (2014). Sustainability: what it is - what it is not. 3rd ed. Voices.	Book
Walker, Lucy. (2009). Extraordinary Rubbish. Production: Production: Angus Aynsley, Hank Levine. Cast: Vik Muniz, Sebastião Carlos dos Santos, José Carlos da Silva Bala Lopes, Suelem Pereira Dias, Isis Rodrigues Garros. 99 min., color.	Documentary
Eguti, Luciana; & Muppet, Paulo. (2011). Climbing. Animation. 2 min., color.	Short film
Itamoto, Cassia M.; & Kurihara, Celina. (2006). The Earth to Spend. Animation. 6 min, color.	Short film
Frederico, Sofia. (2005). Saci Hunters. Cast: Agnaldo Lopes, Áurea Montebello, Cristiane Mendonça, Gleiciane Cardoso, Lucio Tranchesi. 13 min., color.	Short film
Furtado, Jorge. (1989). Flower Island. Narration: Paulo José. 13 min, color.	Short film
Viegas, Diogo P. (2012). King Gaston. Animation. 2 min., color.	Short film
Cadaval, Leonardo. (2008). Pajerama. Animation. 9 min., color.	Short film
Agnos, Chris; & Agnos, Dawn. (nd). Sustainable Human [channel].	Video platform channel

Source: the author.

The following activities were requested as assessment for this week: 1) write a text relating the documentary Programmed Obsolescence with A Carta da Terra; 2) at the end of the text, indicate which SDGs can be related to the documentary; 3) also write your personal reaction to the facts; 4) evaluate pedagogical aspects of the week in the virtual platform forum.

Week 4. Environmental education in formal and non-formal spaces: National Environmental Education Policy (Law nº 9,795/99)

In the fourth week, we sought to highlight the nature of the transmission of knowledge about sustainability: formal (developed within the scope of the curricula of educational institutions) and non-formal (educational actions and practices outside the school environment). To this end, legal support was sought in the National Environmental Education Policy.

The master's students were invited to read a text written by the teacher about formal and non-formal education and Law nº 9,795/99.

In addition, two books, a documentary, eight feature-length films, two short films, a music video and three internet video platform channels were listed as study suggestions (Table 4).

Table 4 . Supplementary material such as Week 4 study suggestions

Title of material	Type of material
Dias, Genebaldo F. (2004). Environmental education: principles and practices. Gaia.	Book

Title of material	Type of material
Pinotti, Rafael. (2010). Environmental education for the 21st century. Edgard Blucher.	Book
Conners, Nadia; & Petersen, Leila C. (2007). Last hour. Narration: Leonardo Di Caprio. Warner Bros. 95 min, color.	Documentary
Zaillian, Steven. (1998). Any price. Performers: John Travolta; Robert Duval and others. Paramount Pictures and Touchstone Pictures. 118 min, color.	Feature film
Grosvenor, Charles. (1993). Once upon a time in the forest. Animation. United States, England and Northern Ireland. 71 min., color.	Feature film
Kroyer, Bill. (1993). Ferngully: Zac and Crysta's adventures in the Rainforest. Animation. Production: Peter Faiman and Wayne Young. 20th Century Fox. 76 min., color.	Feature film
Szabo, Thomas; & Giraud, Hélène. (2014). Tiny: The Movie. Animation. Production: Futurikon: Paris Films. 89 min., color.	Feature film
Miyasaki, Hayao. (1984). Nausicaä of the Valley of the Wind. Animation. Production: Studio Ghibli. 116 min., color.	Feature film

Title of material	Type of material
Renaud, Chris. (2012). The Lorax: in search of the lost trufula. Animation. Cast: Danny Devito, Zac Efron, Taylor Swift, Ed Helms. Universal Picture. 87 min., color.	Feature film
Miyasaki, Hayao. (1999). Princess Mononoke. Animation. Production: Studio Ghibli. 135 min., color.	Feature film
Stanton, Andrew. (2008). Wall-e. Animation. Cast: Ben Burtt, Elissa Knight, Jeff Garlin, Fred Willard, John Ratzenberger, Kathy Najimy and Sigourney Weaver. Production: Disney. Pixar. 97 min., color.	Feature film
Eguti, Luciana; & Muppet, Paulo. (2010). Box. Animation. 10 min., color.	Short film
Rodrigues, Nuno A. (2010). Le royame. Animation. 4 min., color.	Short film
Jackson, Michael. (2005). Earth Song [videoclipe]. MJJ Production Inc. 7 min., color.	Video clip
Reich, Henry; Reich, Alex; Reich, Peter; Elert, Emily; & Salazar, Ever. (n.d.). Minute Earth [canal].	Video platform channel
Thenório, Iberê. (nd). Manual do Mundo [channel].	Video

Title of material	Type of material
	platform channel
Castanhari, Felipe. (nd). Nostalgia Science. Nostalgia Channel [channel].	Video platform channel

Source: the author.

This week's assessment activities were: 1) after reading Law No. 9,795/99, answer 5 questions: i) What do you understand by formal environmental education? ii) What do you understand by non-formal environmental education? iii) What practices do you already do? iv) What practices could you do? v) Thinking about Professional and Technological Education, what products could be created with the environmental theme?; 2) evaluate pedagogical aspects of the week in the virtual platform forum.

Week 5. Environmental indicators: Ecological Footprint and Earth Overshoot Day

In Week 5, master's students needed to read pages 117 to 122 of chapter 3.6 of the e-book Environmental calendar and [...] active methodologies: proposal for a new education. This text fragment briefly explains how the Ecological Footprint and Earth Overshoot Day indicators are calculated and interpreted. It is obvious that the calculation methodology is simplified and the values are approximate, however, they are non-formal educational actions that serve to raise awareness and alert the population about the preservation of the planet. In general, the indicators show

how consumption habits and lifestyles impact the extraction of natural resources (GFN, 2023 ; INPE, 2012).

On the topics, an informative booklet from the National Research Institute and websites of non-governmental organizations, such as WWF and Global Footprint Network, were also made available.

Thus, the week's activities included: 1) reading the text written by the teacher; 2) answer: What do you understand by Ecological Footprint and Earth Overshoot Day?; 3) look for an online Ecological Footprint calculator and calculate your Footprint; 4) prepare a text about the results of your Ecological Footprint, explaining in its conclusion some commitments and actions to reduce your Footprint; 5) evaluate pedagogical aspects of the week in the virtual platform forum.

Week 6. Environmental indicators: Water Footprint and Carbon Footprint

As a continuation of the previous week's topic, the sixth week brought two other important environmental indicators to the screen. The Water Footprint, given in m^3, takes into account the water used in the manufacturing process of a product or in an organization's activities (ABNT, 2017). Similarly, the Carbon Footprint is “the sum of greenhouse gas emissions and removals in a product system, expressed in CO2 equivalents [...]” (ABNT, 2015, p. 2).

To introduce the subject, we recommended reading chapter 3.3, page 91 to 94, and chapter 3.2, page 77 to 80, of the e-book Environmental calendar and active [...] methodologies: proposal for a new education.

After reading, students were asked to perform the following activities: 1) answer: What do you understand by Water Footprint and Carbon Footprint?; 2) look for online Water and Carbon Footprint calculators and calculate your Footprints; 3)

prepare a text about the results of your Water and Carbon Footprints, explaining in its conclusion some commitments and actions so that your Footprints are reduced; 4) evaluate pedagogical aspects of the week in the virtual platform forum.

Week 7. Complexity paradigm x Cartesian paradigm

After raising awareness of sustainability issues, without obviously exhausting the subject, it was proposed for Week 7 to introduce the paradigm of complexity, a moment currently being experienced by humanity, and its effects on education, with an emphasis on transdisciplinarity.

Therefore, two articles were posted for reading: i) Behrens, Marilda A.; & Oliari, Anadir LT The evolution of paradigms in education : from traditional scientific thinking to complexity. Educational Dialogue, v. 7, no. 22, p. 53-66, 2007; and ii) Carpim, Lucymara; Behrens, Marilda A.; & Torres, Patrícia L. Paradigm of complexity in the pedagogical practice of professional education teachers in the 21st century . SENAC Technical Bulletin, v. 40, no. 1, p. 90-107, 2014. In these articles, there are lucid discussions about the need for holistic development of the human being, with the expansion of mental, psychological, ethical, aesthetic , cultural, social, spiritual skills, among others.

In addition to the articles, the suggestions for additional study for this week were five books, presented in Table 5.

Table 5. Complementary material such as study suggestions for Week 7

Title of material	Type of material
Behrens, Marilda A.; & Ens, Romilda T. (2015). Complexity and transdisciplinarity: new theoretical and practical	Book

perspectives for teacher training. Appris.	
Morin, Edgar. (2010). A well-rounded mind: rethinking reform, reforming thinking. 17. ed. Bertrand Brasil.	Book
Morin, Edgar. (2011). The seven pieces of knowledge necessary for the education of the future. 2nd ed. Cortez; UNESCO.	Book
Nicolescu, Basarab. (1999). A manifesto da transdisciplinaridade. Triom.	Book
Saviani, Dermeval. (2012). Historical-critical pedagogy: first approaches. Associated Authors.	Book

Source: the author.

With this collection, the week's activities consisted of responding to two forums to understand and discuss each article posted in the main section. Each student should write their considerations about the texts and respond to at least one colleague, promoting a debate.

At the end of the week, as in all others, students should evaluate the pedagogical aspects of the week in a separate forum.

Week 8. Active methodologies for integrating teaching-research-extension: theory

With the understanding of complexity, and given the importance of transdisciplinarity for the contemporary context of education, the content of Week 8 sought to present tools for educational practices that are aligned with the concepts seen previously: the so-called active methodologies. According to Bacich and Moran (2017) , student-centered methodologies give students autonomy,

critical sense, flexibility to change, engagement, organization, team spirit and unity, and many others.

Among the content available for study this week were a text written by the teacher, an interview with professor José Moran [4], a lecture by professor Lilian Bacich [5], and an article on the application of the STEAM methodology in teaching chemistry and environmental management at EPT.

As complementary material, two books, seven articles and three free distance learning courses were indicated, listed in Table 6.

Table 6. Complementary material such as study suggestions for Week 8

Title of material	Type of material
Bacich, Lilian; & Moran, Jose. (2017). Active methodologies for innovative education: a theoretical-practical approach. I think.	Book
Martinez, Jaime. (2017). The search for method in STEAM education. Palgrave Macmillan.	Book
Berbel, Neusi AN (2011). Active methodologies and the promotion of student autonomy. Semina: Social Sciences and Humanities. 32(1), 25-40.	Article
Diego-Mantecon, Jose M.; Bravo, Arthur; Maple, Oscar; Canizal, Paul; White, Teresa; Recio, Thomas; Gonzalez-Ruiz, Ignatius; & Perez, Maitane. (2017). Development of five STEAM activities with	Article

Title of material	Type of material
KIKS format. In: VIII Ibero-American Congress on Mathematics Education. Anais, 357-365. FESPM.	
Kiryakova, Gabriela, Angelova, Nadezhda; & Yordanova, Lina (2014). Gamification in education. In: 9th International Balkan Education and Science Conference. Anais, University of Bakirçay.	Article
Souza, Samir C., & Dourado, Luis. (2015). Problem-based learning (PBL): an innovative learning method for educational teaching. Holos. 5(31), 182-200. IFPR.	Article
Pereira, Fábio I. (2017). Peer learning and the challenges of critical-sense education. International Journal on Active Learning. 2(1), 6-12.	Article
Fragelli, Ricardo R. (2015). Three hundred: active and collaborative learning as an alternative to the problem of test anxiety. Management & Health. 6 (2), 860-872.	Article
Valério, Marcelo; & Moreira, Ana LOR (2018). Seven criticisms of the flipped classroom. Context & Education. 33(106), 215-230.	Article
Remote Experimentation Laboratory. (nd). Rex Lab UFSC.	Distance learning course

Title of material	Type of material
Mycelium Formation (nd). UFPR.	Distance learning course
Continuing Training in Active Teaching Methodologies. (nd). IFFluminense	Distance learning course

Source: the author.

After students were familiar with the material, the activity in this module was to answer the questions: 1) Did you already have knowledge about the topic? 2) Have you ever applied any active methodology? If yes: share. If not: think and present some activity that you could apply; 3) evaluate pedagogical aspects of the week in the virtual platform forum.

Week 9. Active methodologies for integrating teaching-research-extension: practice

Active methodologies allow students to follow their own itineraries, using different tools to reach the same objective. With this logic in mind, the activity proposed for Week 9 was the production of a video, lasting 3 to 4 minutes, with basic explanations about an active methodology.

Thus, an activity called “evaluation laboratory” was created in Moodle, which allows the delivery, review and peer evaluation of student work. Therefore, the module must be completed in two stages: i) posting the activity, and ii) peer evaluation using a form with multiple criteria, defined by the teacher. For each

stage, the student receives a percentage of the assessment grade. This type of activity fits perfectly into the context of the discipline, as it was not taught how to produce a video, each student needed to use recording software and, if desired, editing.

In Week 9, the activity was only the production and posting of the video. So that all recordings could be evaluated coherently later, a script was established to be followed: 1) explanation of an active methodology; 2) how this active methodology can be applied in the classroom, aiming at teaching-research-extension integration; 3) what are the strengths of this methodology; 4) what the difficulties may be in applying the methodology.

In addition to this delivery, students should evaluate the pedagogical aspects of the week in a separate forum.

Week 10. Active methodologies for integrating teaching-research-extension: evaluation of videos

In the last week, as the course ended, students needed to evaluate their colleagues' videos in a qualitative way.

Two forums were also created for this topic, one to evaluate the pedagogical aspects of the week, and another to evaluate the discipline as a whole.

In addition to the individualized study recovery regime via chat or email, another module called “Forgiveness Week” was opened, in which students could post late activities, without needing to justify missing the deadline.

3. **Results and discussions**

The first finding of the study was the spatial distribution of participants in the discipline since 2020, showing representation from all regions of the country, with a predominance of students from the Northeastern States, as can be seen in Figure

1. Looking at AI separately, the discipline had more participation by IFMT, followed by IFBA, IFPR and IFFarroupilha.

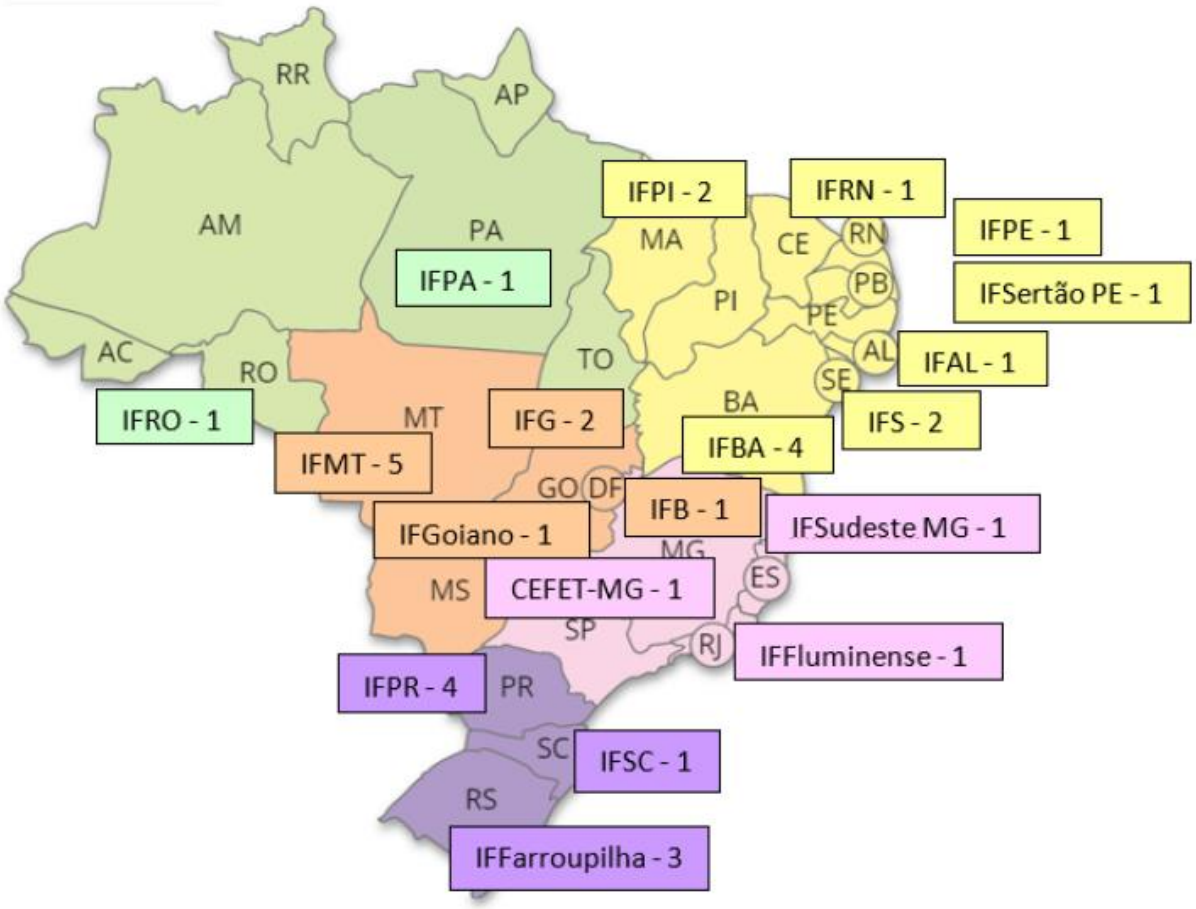

Figure 1. Representative spatial distribution of students in the subject analyzed
Source: the author.

Secondly, it was noticed that not all students recorded an evaluation of the week or the course. This may have happened due to lack of time due to so many other activities in the master's program, as this action was not mandatory to complete the course.

Regarding content analysis, the results can be seen in Tables 1 and 2. Table 1 shows the ten categories detected in the evaluation of the course weeks, and Table 2 shows the ten categories highlighted in the general evaluation of the course.

Table 1. Incidence quantities of the categories identified in the weekly assessments of the discipline by ProfEPT master's students

	Categories									
	1	2	3	4	5	6	7	8	9	10
	Already known content	New content	Content that encourages adoption of personal practices	Content for dissertation or educational product	Content for teaching practice	Content that instigates the need for continued training	Meaningful content learning	Collective learning	Videos of the assessment activity with reflective content	Difficulty in carrying out the proposed evaluation activity
Week 1: evolution of the	15	9	1	3	3	0	17	n/a	15	5

biosphere										
Week 2: deep ecology	2	12	6	3	8	0	14	n/a	21	0
Week 3: SDGs and planned obsolescence	5	6	19	6	7	1	6	n/a	18	0
Week 4: environmental education	9	8	7	6	7	3	2	n/a	n/a	0
Week 5: Ecological Footpri	4	10	22	1	5	0	2	n/a	n/a	0

nt and Earth Overshoot Day										
Week 6: Water Footprint and Carbon Footprint	3	7	11	0	4	0	1	n/a	n/a	0
Week 7: Complexity Paradigm	5	6	0	3	12	6	3	n/a	2	0
Week 8: active methodologies –	12	9	0	3	11	2	3	n/a	n/a	0

theory										
Week 9: active methodologies – practice	4	9	1	1	11	4	3	n/a	n/a	14
Week 10: active methodologies – evaluation	0	1	1	0	1	1	0	11	n/a	4

n/a – not applicable

Source: the author.

The ten categories identified in the analysis of each week of the course (Table 1) were: 1) content already known; 2) new content; 3) content to be included in research, dissertation or educational product; 4) content to be applied to students; 5) content that encourages the adoption of personal practices; 6) content that awakens the need for continued training; 7) significant learning from the content presented and the methodologies adopted; 8) difficulty in carrying out the

proposed evaluation activity; 9) specific videos of the assessment activity with reflective content; and 10) collective learning through interactive methodology.

With a careful observation of Table 1, it is clear that the contents most known by master's students are about the evolution of the biosphere and active methodologies. However, reports of new topics were common as a complement to what was already known.

[...] this first week of content made me get back in touch with some concepts and ideas that I had studied a long time ago and no longer remembered so well. (20201S1)

[...] allowed me to remember some information that I had already come into contact with some time ago, in addition to learning others that I didn't know. (20203S1)

In fact, the topic on the evolution of the biosphere is treated in several stages of formal education and the subject analyzed sought to delve deeper into some issues. Regarding active methodologies, there is currently a lot of research and application of this new perspective. A quick search inBrazilian Digital Library of Theses and Dissertations (BDTD) using the descriptor “active methodologies” revealed almost 40 thousand works on the subject, with 27,369 dissertations and 9,619 theses defended by 2022 (BDTD, 2023a). Even so, it was revealed that this topic was new to 9 students.

[...] the knowledge was completely new about active methodologies and I found it very interesting. (2022111S8)

I had no knowledge on the topic. These teaching and learning strategies place the student at the center of the knowledge acquisition process, make classes more

dynamic and improve the ability to solve problems collaboratively [...]. (202225S8)

Still analyzing this category, it was found that the themes of “water footprint and carbon footprint indicators” and “deep ecology” were the least known.

I didn't know about these features [water footprint and carbon footprint], it's very important that we have a real idea of what we're doing in the world. (2022121S6)

This week's texts were very relevant to me, as I was unfamiliar with the term “Deep Ecology”. (20205S2)

Effectively, making a comparison between the first two categories analyzed, the subject of “deep ecology” was the most talked about topic about being something new for master’s students. Secondly, it was possible to identify that the “Ecological Footprint” and “Earth Overload Day” were also new content for 10 master's students.

I confess that I had not heard of this term, “Ecological Footprint”, I found it really interesting. (202212S5)

I was unaware of the “Earth Overshoot Day” indicator, [...]”. (20203S5)

The topics that were least talked about as being new were about the SDGs and the complexity paradigm, although only 5 students claimed to know about these two contents. When carrying out an advanced search in BDTD relating these terms to education, reduced numbers were reached: 704 for complexity x education, and 67 for SDG x education (BDTD, 2023b and 2023c). It is interesting to note that in category 2 (new content), all themes appeared as new to at least one of the participants in the course.

The next category drew attention due to its personal characterization and the number of mentions about the intention to adopt sustainable practices. What most alerted the participants was the result of the Ecological Footprint and the exposure of the concepts of planned obsolescence. It was noticed that the reflection provoked by the material available can be a stimulus for changing attitudes and habits.

I confess that the documentary [about planned obsolescence] significantly impacted my way of interpreting consumption, as in addition to stimulating a vicious cycle of consumerism, the practice causes environmental and social problems. (202217S3)

[...] it was good to calculate my ecological footprint again, I had done this calculation for some time and I reformulated some goals that had been left aside, such as reducing bathing time, meat consumption and purchasing clothes and shoes. (20203S5)

[...] I didn't believe that my lifestyle and consumption habits were outside the global and Brazilian average in terms of ecological footprint. It became very clear that I need to change some attitudes, especially in relation to transport and food [...]. (202221S5)

These statements also show that sustainability is still an unknown topic for the majority of the Brazilian population, regardless of education. Silveira (2020) concluded, in her study, that elementary school teachers I and II in the State of S Sãoo Paulo do not articulate the social and economic dimensions with the environmental dimension when developing sustainability projects.

Regarding category 4, given the perception of a great correlation between environmental education, the SDGs and consumerism, these points were the most

mentioned to be included in the dissertation or educational product of master's students. In this category, the only topic that was not considered possible to be included in the students' study were the Water Footprint and Carbon Footprint indicators.

When observing the column of category 5 (content for teaching practice) in Table 1, it was noted that all weekly content was considered suitable to be worked on in some way in the classroom. Among them all, the ones that caught the most attention were the complexity paradigm and active methodologies.

It was very important for me to delve deeper into the concept of complexity paradigm, as it is from this perspective that teachers on the campus where I work are developing student training. (202218S7)

[...] I already knew the topic "active methodologies" and had already applied some. During asynchronous activities, due to the Covid 19 pandemic, in which in-person classes were replaced by remote classes, I worked with gamification. (20213S8)

I have been using active methodologies for some time, specifically Problem-Based Learning. (202212S8)

I work with projects on Environmental Education and with the effective participation of students. [It is] Very important to work with active methodologies with our students. (2022113S8)

I learned new active methodologies, mainly with online classes during the pandemic. I have mainly used flipped classes [...]. (2022115S8)

At this point, it is extremely important to highlight that the movement of change in education is already very evident, with the application of contemporary concepts built with basis in reality. As Chaves (1998, p. 7) wrote , "complexity is to the real

world what transdisciplinarity is to the academic world". If all levels of education of all modalities were able to access sustainability knowledge, as Pereira (2022, p. 7) points out, it would be "possible to debate issues such as ethics, empathy, equity, peace, happiness, innovation, resilience and flexibility, for example, which are encompassed by transdisciplinarity". In this sense, Boff (2014) guarantees that only an ecologically centered education would be humanly liberating and extremely democratic, which could transform the current scenario. It is for this reason that active methodologies are standing out as educational alternatives.

The findings in category 6 were a reflection of the previous category, because if a certain topic was considered relevant to be covered in the classroom, it was considered that there is a demand for continued training in these subjects. In this way, it was registered by the students that the complexity paradigm and active methodologies would be subjects of interest for training courses.

> The proposed texts [...] allowed me to reflect that it is necessary to always be in a formative process [...] to develop pedagogical skills that allow our practice to lead students to question, argue, research and criticize reflexively. (2022118S7)

> The opportunity made me realize that I have to improve myself in technology and the ways in which it can contribute to my training and that of my students. (202213S10)

According to Nóvoa (2019) , teacher training must be dynamic and collective, as the school is in the process of "metamorphosis". The author highlights as essential that continued training should not only involve "practical issues or professional preparation, in the technical or applied sense, but understanding the complexity of the profession in all its dimensions (theoretical, experiential, cultural, political,

ideological , symbolic, etc.)" (Nóvoa, 2019, p. 6). At this point, other authors also converge on this thought, such as Freire (2013) , Morin (2011) and Saviani (2009) .

A practical example of this movement was the publication, in 2020, of the so-called City Curriculum, with guidelines related to the SDGs aimed at educators from the São Paulo Municipal Education Network (Rede) in the development of their pedagogical activities. According to the material,

four dimensions are relevant to the transformation of the school from the perspective of integral education and the principles of Education for Sustainable Development (EDS): school physical space, human relations, pedagogical practices and learning themes (São Paulo, 2020, p. 5).

The curriculum includes nine pieces of knowledge that integrate eight transversal key competencies for sustainability, organized by UNESCO, which are relevant to all SDGs. As part of municipal policy, the Environmental Education Center (NEA) of São Paulo City Hall promotes the continued training of the Network's teachers with a focus on EE, guided by the SDGs and the City Curriculum (São Paulo, 2020) .

In places where there is no well-structured public educational policy, it may be the case that teachers do not even know what they do not know, as updates are very rapid, especially in information and communication technology. Therefore, during training courses, current and current issues must be addressed so that they can help teachers understand the world and improve their craft, such as the environment, technologies and futurism.

According to Nóvoa and Alvim (2021) , pedagogy without computer mediation is no longer possible, as

integrating digital into teaching work is more than incorporating a “technology”, it is recognizing the reverberations that new ways of being, acting and thinking – constituted in the digital era – cause in schools and being able to integrate them as fundamental references in the repositioning of teachers (Nóvoa & Alvim , 2021, p. 12).

Corroborating and expanding this discussion, Schlemmer et al. (2020, p. 1) talk about “an OnLIFE Education, in a hyperconnected reality, in which the “real” and “virtual” are (con)fused, instigating institutions, teachers and students to rethink the educational system, as an ecosystem”.

Even so, 41% of master's students revealed difficulties in recording, editing or sending the video requested as an assessment activity in Week 9. These statements appeared in category 10 of Table 1, showing a strong correlation between this category and the need for continued training.

I had an odyssey to record the video, but I finished it. (202212S10)

[...] the challenge was even greater in relation to preparing the video, choosing a program, editing, size, etc. But, it was a valid experience and adds knowledge for life and the opportunity to learn more about technologies. (2022111S10)

[...] I need to develop my technological skills to record videos. (202225S10)

Regarding the perception of significant learning of the content (category 7), according to the master's students, interestingly, the themes of biosphere evolution and deep ecology were the most mentioned. However, this analysis should not be done in isolation, as the records have great convergence with the results from category 9 (presentation of videos with reflective content).

The video [The DNA Journey] provokes reflections, questions, breaks down prejudices and shows that we have the same origin. [...]. I learned a lot from the content covered. (2022117S1)

For me, learning was stimulating, as I didn't know that the extinction of megafauna was directly linked to the human presence in these regions. The reflection on how we treat our planet was also incredible, as we only have a transitory and ephemeral possession of the earth, in short, this content makes us think about how we act in our daily lives, when faced with environmental issues and how we can improve our attitudes . (202221S2)

According to Kioupie and Voulvoulis (2019) , several skills must be sought when developing curricula and content to achieve significant learning in EpS. The authors list, as examples: knowledge of the state of the planet, systemic thinking, future-oriented thinking, strategic thinking, critical thinking, modeling sustainable behavior, self-awareness, emotional intelligence, integrated problem solving problems, collaboration and the ability to use media.

The last class to be analyzed is that identified as collective learning (category 8). Approximately a third of the students noted that it was stimulating to be evaluated and evaluate their colleagues, as they felt part of the teaching-learning process, creating emotional bonds even in an EaD course.

[...] the learning was very special, because I had to read materials, prepare a presentation for you, and you did the same, and this brings a different meaning to our learning, because it is from situations like these that we We have access to the perceptions of our classmates and with this we are able to build knowledge collectively. I also believe that these moments strengthen the feeling of democracy, where there is respect for the plurality of voices. (20207S1)

The opportunities to talk to colleagues about activities, different views, etc., also add a lot. It is collective learning. (20203S1)

The content provided something new with the assessment we had to make on our colleagues, innovating and teaching us how to learn autonomously and participatively. (202224S1)

The proposed proposal was valuable for seeing another classmate present his proposal and vision of how it would impact the student's educational path. (202216S1)

Once the assessment stage for each week was completed, the subject was analyzed in general, as shown in Table 2.

Although one participant felt that the course content was superficial, probably due to academic training in the area, the majority of students considered the material adequate. In any case, the result exposes a weakness that must be taken into consideration and the content must always be reviewed and updated.

Table 2. Incidence quantities of the categories identified in the evaluations of the discipline in general by ProfEPT master's students

Categories	Incidences
Good curation of material	18
Course helped with content for dissertation	9
Course helped with pedagogical practice	9
Good interaction methodology through forums to exchange experiences	8
Desire for in-person classes and study group formation	8

Insufficient time to delve deeper into the content of study suggestions	7
Course helped to adopt personal practices	6
Good assessment methodology with different types of activities	2
Sufficient time to prepare activities	1
Course with superficial content	1

Source: the author.

In general, it was recorded that the content of the subject helped with the dissertation, pedagogical practice and the adoption of personal practices, in addition to the exchange of knowledge through interaction through the discussion forums on the Moodle platform being highlighted as a positive experience. . The desire to have face-to-face classes and the continuation of discussion through study groups also appeared in the speeches of the master's students.

In a generalized way, it was noticed that the main potential and the main limitation of the application of this DS were, paradoxically, at the same time, the fact that it was taught exclusively remotely . The potential is anchored in the fact that it is accessible to all of ProfEPT's 38 AIs, which spreads knowledge. The limitation is due to the lack of face-to-face debates, which are undoubtedly richer than debates in forums in virtual environments, devoid of emotions and feelings.

Regarding the duration of the course, some students reported that they were unable to delve deeper into the content of the study suggestions due to lack of time.

I regret having been unable, due to the rush, to read the instructions/suggestions. (202224C)

Maybe I wasn't able to carry out the activities with all the dedication they deserved due to the rush, because [...] reconciling work, master's degree and personal life is not always very simple. (20203C)

On this issue, the discussion is broad, as the professional master's degree aims to train working professionals, that is, it welcomes student-workers. Therefore, it is clear that students do not have the time they would like to study, which certainly impacts their education.

4. **Final considerations**

At the end of this study, based on the students' speeches, it is considered that the DS presented is fulfilling the objectives of promoting the apprehension of content related to sustainability sewn with threads of transdisciplinarity.

For the study in question, specifically, levels of transdisciplinary, individual and collective processes and connections were identified: i) mental constructions, reflection and awareness; ii) change in attitude and individual action; iii) sharing acquired knowledge with peers; and iv) desire to take the assimilated understanding to an external group (family or school community).

In view of what has been analyzed, continuing education is essential for teachers, mainly based on subjects that can be addressed through a transdisciplinary approach. It is clear that the teacher's job is to teach, but just as important as that, it is to learn. Ever. The world changed.

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