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Title **Design-Based Research (DBR) in Teacher Education. Technological-Pedagogical Fluency with Open Educational Resources (OER)**

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Abstract Expanding the Technological-Pedagogical Fluency of teachers in the context of Basic Education is a concrete and urgent challenge to be solved in the Brazilian scenario. For this, teacher education processes have been implemented according to the foundation of Design-Based Research (DBR). Phases of diagnosis, planning, implementation, observation, and redesign have generated intervention and production cycles to develop solutions and con-

tribute to the resolution of real problems. In this scope, a pedagogical product resulting from DBR is analyzed. This is a proposal for an emerging education process on Open Educational Resources (OER) implemented through a Small Open Online Course. The empirical results demonstrate the potential of DBR applied in an educational context to promote teacher (co)authorship. This is possible through the creation and free sharing of OER in public repositories. As conclusions, it is highlighted that teacher education supported by the DBR epistemological foundations increases Technological-Pedagogical Fluency and, consequently, enhances disruptive educational innovation.

Keywords Design-Based-Research
teacher education
Open Educational Resources (OER)
Technological-Pedagogical Fluency (TPF)
educational innovation.

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Design-Based Research (DBR) in Teacher Education: Technological-Pedagogical Fluency with Open Educational Resources (OER)

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1.0 Introduction

The primary purpose is to systematize theoretical-methodological bases and education research results in the context of teacher education guided by the *Design-Based Research* (DBR) epistemological foundations (theory-practice coupling). The interpretative-critical analysis clarifies that iterative cycles of DBR extend Technological-Pedagogical Fluency (TPF). Consequently, they enhance disruptive educational innovation by promoting teacher (co)authorship through the adaptation, remix, creation, and free sharing of OER in public repositories.

The results of DBR generate interventions and solutions based on the problems considered practical challenges in daily educational life. This directly impacts the entire educational environment, from the dynamics of the elaboration and transposition of public policies to the organization of curricula, the creation of contextualized projects and proposals, and the concrete challenges of teaching and school management. For this reason, educational research guided by the DBR epistemological foundations always has a theoretical-practical nature, considering the more significant number of aspects and categories related to the context and the participants involved.

In this text, the iterative cyclical dynamics focused on processes of teacher education on Open Educational Resources (OER) implemented through a *Small Open Online Course (SOOC)*. In each iteration, the material, activities, and didactic-methodological organization of the course were evaluated and improved. The redesign was defined by gradually improving the educational solution created throughout the process in congruence with the guidelines of Technological-Pedagogical Fluency (TPF) undertaken as educational innovation.

2.0 *Design-Based Research* (DBR): theoretical-methodological orientation for educational research

DBR emerged in the United States in the 1990s. According to Peterson and Herrington (2005), the precursors were Ann Brown and Allan Collins. Since then, the number of research and publications carried out in various contexts has increased (Anderson & Shattuck, 2012). In Brazil, the most widespread publications are within a temporal curvature with exponents in the last decade (Matta et al., 2014; Mülbert & Pereira, 2017; Ferreira Nobre et al., 2017; Plomp et al., 2018; Ramos et al., 2009, 2010).

There is a diversity of designations for the "Design Research" typology. On this, Van den Akker et al. (2006) stated that "Design Research" is a common label for a "family" of related investigation approaches with different designations but common characteristics. Wang and Hannafin (2005) also pointed out that the designations, since "Design Experiments" proposed by Allan Collins in 1992 until the creation of the group of researchers gathered in the Design-Based Research Collective (2003), have different methodological focuses but similar objectives and approaches. Box 1 provides a systematization developed by Wang and Hannafin (2005) of the main approaches.

Table 1

Methodological approaches of DBR

Variant & Reference	**Method**
Design-based research (*Design-Based Research Collective*, 2003)	Often conducted within a single setting over a long time.
	Iterative cycles of design, enactment, analysis, and redesign.
	Contextually dependent interventions.
	Document and connect outcomes with development process and the authentic setting.
	Collaboration between practitioners and researchers.
	Lead to the development of knowledge that can be used in practice and can inform practitioners and other designers.
Design experiments (Collins, 1992)	Comparison of multiple innovations.
	Characterizing the messy situation.
	Multiple expertise in design.
	Social interaction during design.
	Flexible design revision and objective evaluation.

	Developing a profile as findings.
Design research (Edelson, 2002)	Designs both directly propel the development of practice and improve researchers' understanding.
	Four characteristics: research driven, systematic documentation, formative evaluation, generalization.
	Design generates three types of theories: domain theories, design frameworks, design methodologies; these theories go beyond the specific design context.
Development research *(Van den Akker, 1999)*	Begin with literature review, expert consultation, analysis of examples, and case studies of current practice.
	Interaction and collaboration with research participants to approximate interventions.
	Systematic documentation, analysis, and reflection on research process and outcomes.
	Using multiple research methods; formative evaluation as the key activity.
	Empirical testing of interventions.
	Foundations as generated knowledge in the format of heuristic statements.
Developmental research (Richey, Klein, & Nelson, 2003)	*Type 1* (emphasizing specific product or program) and *Type 2* (focusing on the research process).
	Begin with defining research problem and reviewing related literature.
	Different participating populations in Type 1 and Type 2 developmental, research during different phases.
	Various forms of data collection depending on the research focus.
	Employ multiple research methods, such as evaluation, field observation, document analysis, in-depth interview, expert review, case study, survey etc.
	Data analysis and synthesis include descriptive data representations, quantitative and qualitative data analyses.
	Reports of developmental research are long and can be published in various types of sources; websites

	are useful to report massive data sets.
Formative research (Reigeluth & Frick, 1999)	Drawn from case-study research and formative evaluation.
	Used to improve instructional systems and to develop and test design theory in education.
	Preferability (i.e., effectiveness, efficiency, and appeal) over validity.
	Two types: (a) designed case studies and (b) naturalistic case studies.

Based on her teaching activities and extensive experience as the American Educational Research Association chair, Ann Brown argued that research should be conducted in the classroom with students and teachers. This methodological perspective was the starting point for the development of DBR and its academic dissemination. Bell (2004) defended DBR with methodology status, stating that it can facilitate innovation in the development of investigations through the sharing of knowledge and practices between participants. Barab and Squire (2004) considered DBR a set of approaches developed in real contexts to generate new theories, educational artifacts, and pedagogical practices. According to Romero-Ariz (2014, p. 2), it "brings research closer to the problems and needs of teachers, offering relevant results for the improvement of teaching and for decisions about education".

DBR produces research results aimed at particular educational situations that require problematization, critically informed activity, and innovation to generate creative and contextualized solutions. This involves managers, teachers, and students. This characteristic was underlined by authors such as Wang and Hannafin (2005), Herrington et al. (2007), Collins et al. (2004), the *Design-Based Research Collective* (2003), and McKenney and Reeves (2012). The methodological flexibility, both in the quantitative and qualitative perspective, implies a series of theoretical, methodological, process, and procedure possibilities for systematizing and analyzing the data, as well as for knowledge production and redesign. At the same time, the thematic delimitation, accurate diagnoses, collaboration of all, and deliberate options are collectively fundamental in order not to compromise routes and results. Thus, the concern with the quality of the data and the rigor in the recording and analysis systems are essential in the face of the criteria of validity, legitimacy, and generalization.

The interventionist nature and the collaboration between researchers and participants are particularities of DBR that mobilize and require understanding educational research as a collective construction in all phases and iterative cycles. According to Ireland (2003, p. 22), “few investigators nowadays have the luxury of creating their vision with-

out the participation of others [...] they need to understand the people they design for".

The purpose of DBR of generating development and producing creative solutions to be validated by the participants in each context is what provides foundations for the interventionist contribution in concrete reality. In the contemporary context, this is directly linked to curricular knowledge, the technological-pedagogical content of communicative dynamics in digital networks, public policies, and institutional management and governance, among others. It is in this field of contexts and educational demands that innovative solutions such as *Massive* or *Small Open Online Courses* (MOOC/SOOC) are being created, developed, and redesigned (Chauhan, 2014; Ross, 2012). These are environments with high flexibility in the spatial-temporal routes of study, interaction, and interactivity. Typically, they are courses provided for open and flexible activities and teaching materials such as the Open Educational Resources (OER).

Both Herrington et al. (2007) and Wang and Hannafin (2005) considered DBR systematic and flexible given the iterative design, development, and implementation dynamics. According to the Design-Based Research Collective (2003), "the explicit and comprehensive concern in research based on design-based research allows using methods that promote results that have the power to generate knowledge that applies directly to educational practice" (p. 7). This allows one to infer that educational research guided by the DBR epistemological foundations encompasses various strategies and data production, systematization, and analysis procedures. Therefore, this characteristic makes it a potential generator of process and procedural creations capable of contemplating the cultural, ethnic, social, economic, political, and curricular differences of each group or educational institution.

Plomp (2013) was categorical in emphasizing that DBR research is developed to create solutions to complex problems of educational practice. Undoubtedly, this emphasis of the author regarding the complexity of the problems in the actual context refers to the understanding that the DBR epistemological foundations require clarified epistemological conceptions to generate intervention and development of innovative educational solutions. In the interim, it involves policies, educational actions, projects, teaching-learning strategies, materials, products, systems, teaching, management, and governance in real contexts. In this line, Puntambekar (2018, p. 383) stated that the "iterative development of an innovation in which the design is put to test in an authentic context is at the core of DBR".

The theoretical-methodological procedures that make quantitative-qualitative methods and techniques more flexible allow systematizing knowledge in three dimensions: a) exploratory in phases of collaborative diagnoses, b) descriptive with evidence in the most relevant processes and findings in each phase and iterative cycle, and c) ex-

planatory with the elaboration of design principles. According to Herrington and Reeves (2011, p. 598), design principles work like “as informed reusable guidelines for others wishing to create their own solutions to educational problems across sectors”. Thus, the retrospective nature is preserved in terms of evaluating the planning and stages already carried out, and the prospective nature when delimiting useful indicators for new stages. Hence, it is coherent to understand that the more collaborative and dialogical the development process of the phases is, the more comprehensive and complete the design principles can be in order “to improve pedagogical practice and promote student engagement”. (Herrington & Reeves, 2011, p. 594). Thus, consequently, the validity and the power of recontextualization (extension of the reach) of the results is gradually established promoting continually the educational innovation mediated by technologies, in our case OER.

The weights of the three dimensions mentioned is not asymmetric, considering that, in each segment, it is necessary to choose or create the most appropriate techniques and procedures. The goal is always to produce specific knowledge about a particular situation considered problematic. This situation, well mapped in terms of diagnosis, becomes the case in focus for exercising creativity in proposing innovative solutions.

It should be noted that, as in other research approaches and typologies, it is also essential to delimit the universal methodological requirements, such as the elaboration of the central research problem, objectives, hypotheses, observation techniques, data registration, validation, and analysis, and dissemination among peers and community. In this regard, it becomes clear that, due to the epistemological foundations governing DBR, the differential is accentuated precisely in the iterative cycles of design, development, implementation, evaluation, and redesign to consolidate innovation. That is, although the knowledge produced is coupled to the case in concentration, educational knowledge is elaborated that does not have only utilitarian restrictions. However, in the explanatory dimension, conceptual potential and theoretical modeling are achieved.

Figure 1, elaborated by the authors based on the works mentioned, shows a graphical systematization supported by grouping characteristics and definitions highlighted in the consulted literature.

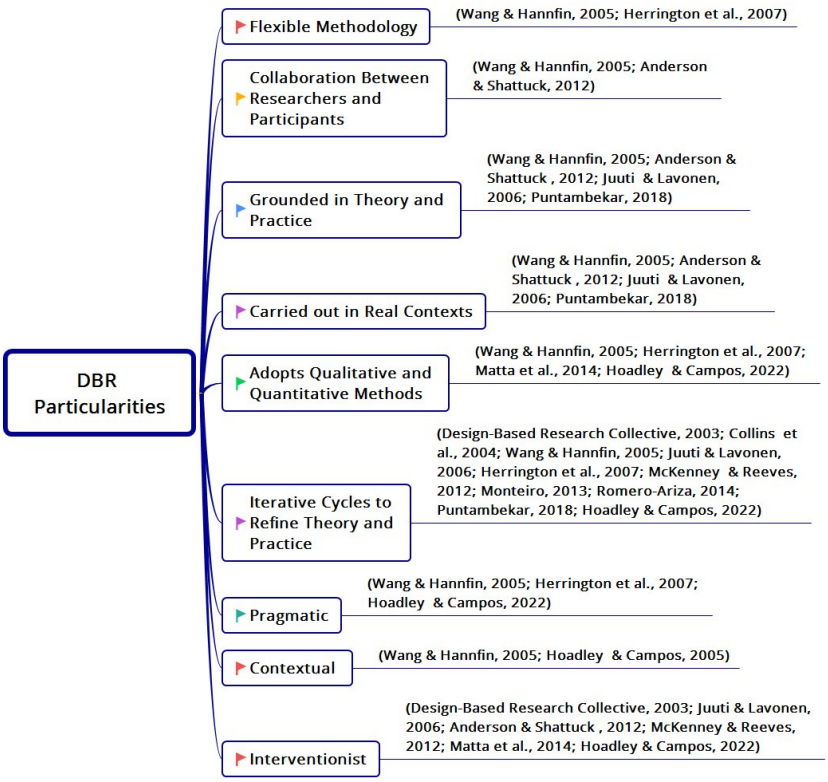

Figure 1. DBR Characteristics

Analyzing the pluralism and breadth in the characterization of DBR, a conceptual proposition is systematized, considering it a type of research of cyclical and contextual nature, which emphasizes creativity and innovation in interventions and generates an impact on pedagogical mediation. Zheng (2015) indicated that several iterations are needed to refine the theory, methods, or tools being investigated. DBR integrates qualitative and quantitative methods and is carried out in dynamic contexts in collaboration between all those involved. The methodological movement encompasses iterative cycles of design, development, implementation, analysis, and redesign, with a priority focus on creating innovative solutions to the problems/challenges of education. In this movement, innovation happens through the "creative search for original and non-standard solutions to different pedagogical problems" (Demyanenko, 2020, p. 91).

Therefore, in the iterative cyclic process of DBR, research generates knowledge production anchored in the collaboration and creativity of all those involved in the solutions to the problems considered most pressing. Participants evaluate, analyze, understand, and deliberate based on theoretical-practical foundations from both the epistemic field of Pedagogy and Technology. The experiences and theoretical-intellectual input are valued all the time by those involved so that solutions may be considered, implemented, and consolidated. This is related to several aspects of an educational reality such as those highlighted by Juuti and Lavonen (2006): pedagogical resources such as textbooks, games, software, career plans, management systems, les-

son plans, and legal documents, but also include processes, activities, curricula, and theories.

2.1 DBR design, development, and implementation models

The flexibility of DBR enables a diversity of models with several phases to guide research design and development. The models include the theoretical foundation, the definition of the research topic, the context in which it will be developed, the participants, the design, development, implementation, iterative cycles, results, and the definition of design principles or theory. According to Herrington and Reeves (2011), these created principles are the theoretical-methodologies bases that serve to guide new studies and developments. Figure 2 illustrates the proposal of Reeves (2006) for the design, development, and implementation of DBR containing four phases

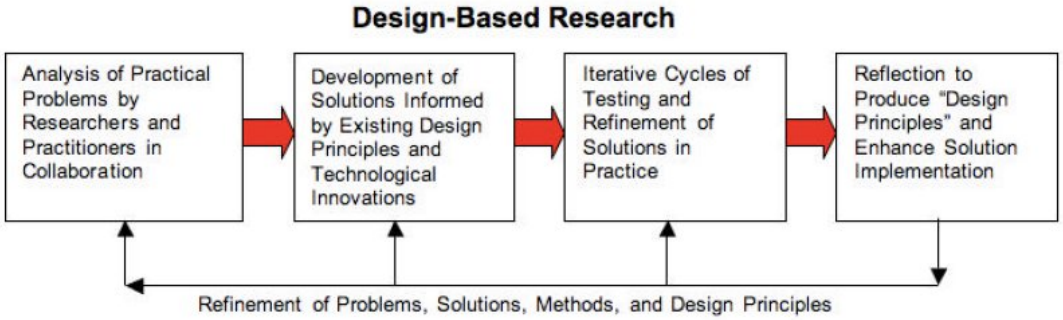

Figure 2. DBR phases proposed by Reeves (2006)

Among the diversity of existing models, we also highlight that of McKenney and Reeves (2012), containing three phases plus the final evaluation and theoretical understanding, the model by Wademan (2005), cited by Plomp (2013), with five phases, the Integrative Learning Design Framework model presented by Bannan (2007), with four general phases and subdivisions, and the model by Romero-Ariza (2014) with three phases.

In the models used to develop RBD, regardless of the number of phases, some actions are basic (Mazzardo, 2018):

- performance of the theoretical foundation, the analysis of the context, and the identification of the research problem in collaboration with the participants;
- design and development (construction) of the solution;
- implementation, analysis, refinement, and redesign carried out through iterative cycles in collaboration with the participants to improve and refine the pedagogical intervention or artifact;
- final evaluation with the definition of the design principles and the theoretical contributions of the research.

The development of research with the DBR approach, which is con-

textual, interventionist, and involves researchers and participants, requires observing models to obtain methodological rigor.

3.0 Congruence between DBR and Technological-Pedagogical Fluency (TPF): production of disruptive educational innovation with OER

Educational innovation supported by research results is a permanent challenge because it requires systematic production, rigorous analysis, critical interpretation, and propositional inferences. In this line, the congruence between DBR epistemological foundations and Technological-Pedagogical Fluency (TPF) principles supports creativity to solve problems in the real context, understood as educational innovation. In this case, the theoretical-methodological input of both DBR and TPF generates educational innovation movements with OER. Based on the propositions of UNESCO (2012, 2019), the OER are part of an international movement to democratize access to knowledge, especially by promoting the practice of the five freedoms: retain copies, reuse, revise, remix, and redistribute (Wiley, 2014). For this, it is necessary to develop an accurate and critical understanding of a wide range of topics that involves, for example, copyright, open licenses, the public domain, digital culture, free software, the integration of technologies in curricula, policies for the production and distribution of teaching materials, etc.

The reach of the conceptual potential, theoretical modeling, and scientific quality of DBR as research aimed at improving practices is directly linked to the development of TPF as knowledge production around contemporary topics in the real context. TPF is required to diagnose, assess, analyze, plan, validate, and recontextualize design and redesign results with a view to solving the problems identified as priorities. Based on the values of sociocultural diversity and plurality of ideas and conceptions, TPF involves actions and retrospective and prospective reflections of the teaching-learning process. It represents the theoretical-practical knowledge of educational processes mediated by technologies. In close congruence between TPF and DBR, educational innovation is produced, especially around OER, which are based on the foundations of the democratization of access to knowledge and education as a universal right. This includes actions to instigate reflection, criticality, autonomy, collaboration, authorship, coauthorship, and reflection on teaching performance (Mallmann et al., 2013).

TPF has a technical, practical, and emancipatory nature that implies contemporary skills, fundamental concepts, and intellectual capacities (Committee on Information Technology Literacy, 1999). This is necessary to reach the DBR epistemological foundations and to fully exercise the practice of the five freedoms of OER: retain copies, reuse, revise, remix, and redistribute. It is, therefore, more than just theo-

retical or practical knowledge about technologies or resources, as it requires study, research, and understanding of reality that involves explaining the how and why of educational solutions in each context. Thus, the educational innovation resulting from research supported by DBR in convergence with TPF mobilizes the critical analysis of complex situations related to reflection and problem solving based on technology.

TPF contemplates retrospection and prospection around the teaching-learning process, enabling the validity and recontextualization power of the results. It is characterized by “knowing how to do the best in each situation, with each resource, with this not happening in improvisation, but being the result of education" (Mallmann et al., 2013, p. 4). This involves

> Understanding, using, and creating digital information and communication technologies in a critical, meaningful, reflective, and ethical way in various social practices (including school ones) to communicate, access and disseminate information, produce knowledge, solve problems, and exercise protagonism and authorship in personal and collective life (Brasil, 2018, “General Competences in Basic Education” section).

In this context, an educational process that enables qualified and meaningful learning is necessary. In other words, a process that goes through “experimentation, innovation, and the testing of new modes of pedagogical work. And a critical reflection on its use” (Nóvoa, 1992, p. 16). Therefore, by providing opportunities for processes of teacher education in OER in a cyclic DBR process design, development, implementation, analysis, and redesign, TPF becomes fundamental to consolidate educational innovation through authorship, (co)authorship, and creation of OER.

Da Cunha (2008) stated that innovation breaks with traditional ways of teaching and learning and arises as a response to problem situations. In short, it is about transforming practices, models, technological-pedagogical solutions, theories and tools. Thus, developing arguments and justifying choices, methodological paths, materials, systems, and samples are fundamental aspects for the rationality of processes and implementation of adequately contextualized innovative solutions.

The central focus of DBR is to conduct educational research to map the priority problems/challenges in the context of those involved and propose improvements in the teaching-learning process. Therefore, the perception of teachers about the need for change and collaboration during the development of DBR is fundamental for innovation to happen. The teacher acts as an active subject, implying that the educational processes are articulated with the felt and conscious needs (Aguilar, 2019).

Stenhouse (2003, p. 196) argued that a teacher may be innovative in three ways: “a) as an independent innovator at the classroom level; b) [...] acting as an advocate for innovation among their peers; c) ultimately, it is the teacher who must carry out the innovation at the classroom level”. However, although teachers are assigned the responsibility to innovate, doing so alone is a somewhat limited task. According to the same author, “[...] individual works are ineffective if they are not coordinated and supported [...]” (Stenhouse, 2003, p. 222). This means that spaces for sharing experiences among peers, partnerships with pedagogical coordination, and student collaboration also imply the potential of educational innovation to improve contexts.

According to Stenhouse (2003, p. 197), efforts to produce improvements in work define a broad professional with “the capacity for autonomous professional self-development through systematic self-analysis, the study of the work of other teachers, and the verification of ideas through classroom research procedures”. These characteristics are in line with the profile of an innovative teacher and also of a researcher teacher.

Educational problems are the starting point of DBR (Plomp, 2013). On the other hand, the point of arrival is the proposition of solutions to problem situations that lead to changes in contexts based on the collective investigation of reality. However, it is necessary to understand that in education research, when discussing educational problems, there is a wide range of possibilities. The clipping systematized here revolves around the educational process of teachers for the improvement of TPF with OER.

In accordance with the characteristics of innovation, Amiel and Reeves (2008) signaled the theoretical-methodological potential of DBR in the implementation of research whose central theme is the integration of technologies in the school context and pedagogical practices:

1. teachers become active partners in identifying priorities for researching and collaborating throughout the process;
2. knowledge of the reality of the school environment and engagement with professionals increase the likelihood of defining research topics relevant to the context and with social responsibility;
3. iterative cycles developed and refined in collaboration with participants are suitable for addressing the complexity inherent to research on integrating technologies into pedagogical activities;
4. the commitment to the intervention of DBR in real-world contexts and improving the knowledge of all involved.

According to the interpretation of Matas Terrón et al. (2004, p. 2),

"innovation is the effort of an agent in an attempt mainly to obtain an improvement substantiated by the field of knowledge where it is intended to be developed". To Imbernón (1996, p. 64), educational innovation "is the attitude and process of inquiry of new ideas, proposals, and approaches, carried out collectively, to solve practice problems, which will accommodate a transformation in the contexts and institutional practice of education".

The potential for educational innovation when it comes to the improvement of TPF with OER via DBR problematizes understandings and allows connecting research to new solutions and new modes of production. In addition to rendering the practice more systematic, flexible, rigorous, and cautious, they make concrete the possibility of increasing the quality of education. Aguilar (2019, p. 11) corroborates in this sense upon considering that "educational innovations go hand in hand with the development of teachers of the institution where they are". Moreover, according to Pico et al. (2020, p. 398), innovation requires "a set of conditions for sequencing actions that will allow for achieving the proposed objective". Therefore, new artifacts and new modes of production, in addition to making the practice more systematic, flexible, rigorous, and cautious, make concrete the possibility of increasing the quality of education.

From this point of view, educational innovation causes changes not only in practice but also in theory; that is, it is always a formative process of improving TPF. According to the postulates of Brown (1992), it may be understood that iterative cycles generate conditions for formative experiences that involve a wide set of factors, such as didactic materials, study activities, technological resources, and evaluation and regulation systems. This constitutes disruptive educational innovation, given that it is "a planned and intentional process that breaks patterns, ideas, and conceptions, contributing to transformations and improvements that go beyond the educational sphere and advance to the social, political, and economic context in an emancipatory perspective" (Lauermann, 2022, p. 151).

Therefore, from the epistemological and social, economic, cultural, and educational points of view, issues of rigor, ethics, reliability, validity, and legitimacy come into play. These are pertinent and latent concerns in the international literature since it seems clear that discussing and clarifying these milestones is a necessary condition to guarantee the quality and scientific consolidation of DBR.

4.0 DBR *in the Small Open Online Course (SOOC)* for teachers about OER

The results of DBR, in congruence with TPF, generate innovative and disruptive educational solutions made explicit by the movements of development, implementation, evaluation, and systematization of

design principles (theory that guides new development cycles and grounded practices). The innovative educational solution that has been cyclically developed since 2016 is a process of teacher education on OER aimed especially at professionals in the public Basic Education network in Brazil. It is a *Small Open Online Course (SOOC)* titled "OER: Education for the Future". This course is one of the results of a doctoral research in education[1] developed through the theoretical-methodological procedures of DBR. The course workload is 40 hours, and the general objective is to develop TPF in collaboration with the participating teachers as theoretical-practical knowledge about OER that allows integration into materials and teaching practices. The course has an open license (CC BY SA), being itself an OER that may be adapted/remixed by whoever is interested. Figure 3 systematizes the phases and characteristics of DBR applied to the SOOC on OER in the context of improving the TPF of all those involved.

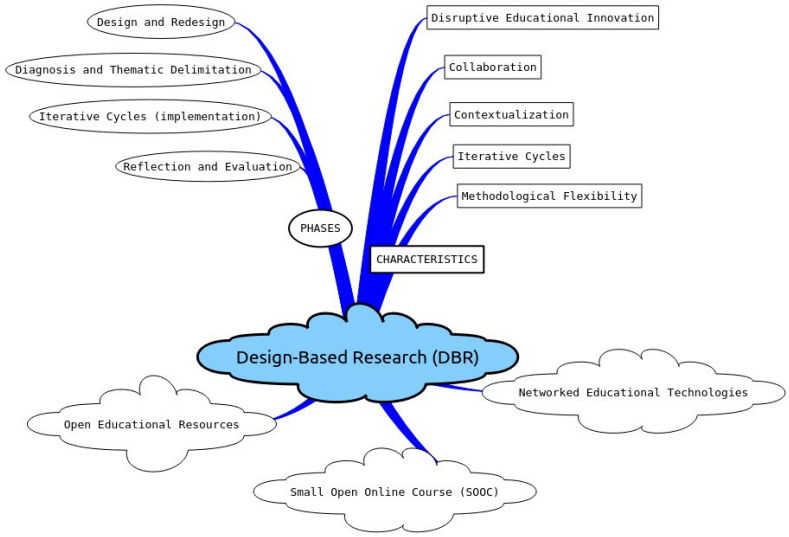

Figure 3. Phases and characteristics of DBR in the SOOC titled "OER: Education for the Future"

From Figure 3, it is made explicit that, in the context of the DBR generating the innovative educational solution that is the SOOC titled "OER: Education for the Future", we opted for the model of Reeves (2006), Herrington et al. (2007) and Herrington and Reeves (2011), which consists of four phases:

Phase 1 – Research Topic and Participants

Phase 2 – Design of the Educational Proposal

Phase 3 – SOOC Implementation and Iterative Cycles Development

Phase 4 – Final Evaluation and Organization of Design Principles

In the analysis of the design and results of the "OER: Education for

1 A PhD research in education at the Open University (UAb), Portugal, conducted by Mara Denize Mazzardo with the supervision of Ana Nobre (UAb) and Elena Maria Mallmann (UFSM).

the Future" course, aspects of Phases 3 and 4 are highlighted below. The constant need to organize and produce teaching materials, especially digital ones, motivated the participation of teachers in the course, as they are challenging activities in the concrete and real context of teaching. This was made evident in the application of the diagnostic survey (Phase 1) and course evaluation survey (Phase 4). Figure 4 shows the contents and

activities of the course constantly improved in the dynamics of iterative cycles.

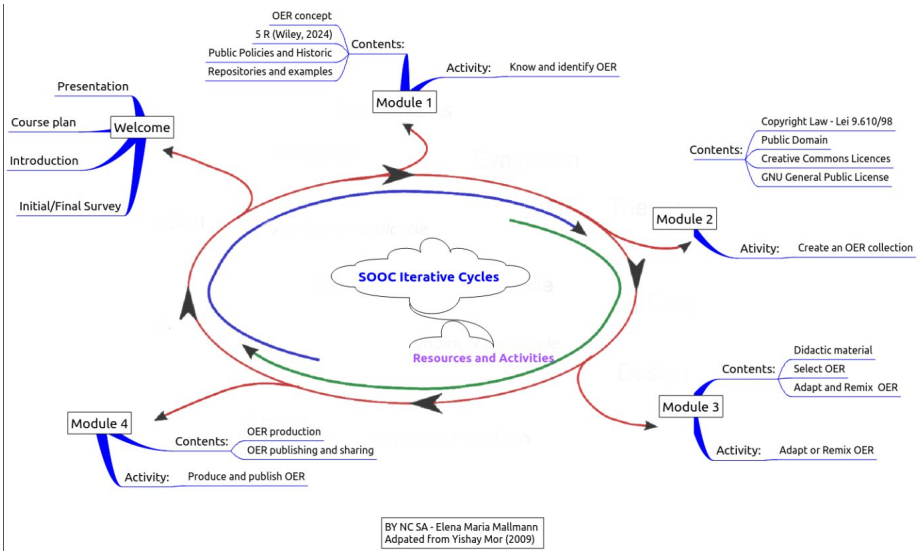

Figure 4. Contents and Activities in the Iterative Cycles of the SOOC

The educational proposal includes activities to get to know, identify, produce, and share OER. The iterative cycles to develop TPF as a refinement of theory and practice, one of the main characteristics of DBR, are formed by design, implementation, analysis, and redesign. “After each edition of SOOC, the team of researchers had subsidies to carry out more in-depth analyses and deliberate prospectively” (Mallmann et al., 2022, p. 107). Thus, the evaluation of the SOOC was carried out in collaboration with participants and with the observation of the principle of Wang and Hannafin (2005), according to which the data are analyzed immediately and continuously in the development of the iterative cycles and, retrospectively, at the end of the course editions. During the development, the evaluation took place through the forums and monitoring of the activities and, retrospectively, with the analysis of the results and data obtained in the evaluation survey of each course edition.

Thus, next, the analyses of 17 iterative cycles corresponding to the 17 editions of the SOOC titled "OER: Education for the Future" from 2016 to 2021 are highlighted. A complete timeline detailing contexts and participants involved during the period may be found in Mallmann et al. (2022, p. 51). In all editions of the

SOOC, various OER were identified, selected, remixed, adapted, produced, shared, and published by the participants. The advances and difficulties were identified in the posts in the forums and through monitoring the activities (Figure 5).

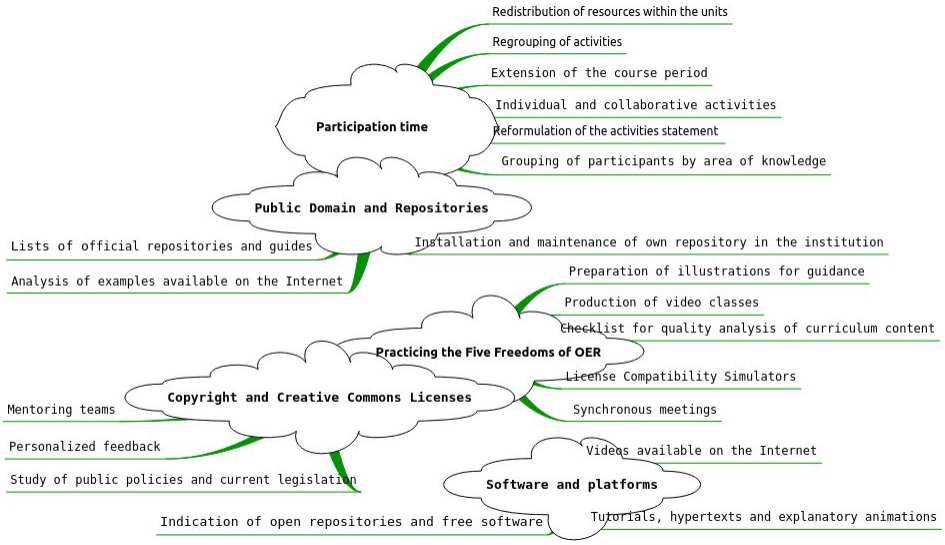

Figure 5. Redesign

Based on the synthesis in Figure 5, one may observe that the main difficulties were concentrated in TPF around aspects such as identifying OER licenses, finding OER in repositories, the lack of culture of participants in observing copyright in resources available on the Internet, little practice to adapt existing OER or produce original OER, finding OER specific to each area of knowledge, sharing resources with peers unknown or devalued, career plans with low openness to innovative educational processes. To respond to the identified difficulties, complementary teaching materials were produced, as well as video classes and tutorials, more detailed clarifications in the forums, and a reduction in one course activity (the initial design included five activities). Throughout the editions, a reconfiguration implemented was the mediation and monitoring of a group of tutors that enabled reviews, interactions, and personalized feedback.

It is noteworthy that the course, by provoking reflections on didactic-pedagogical practice and, consequently, theoretical-practical changes, has an educational innovation nature since it is considered that educational innovation is linked to any intentional modification of processes, resources, or educational practices (Medina & Navío-Gàmez, 2018). Expanding and enhancing TPF helps teachers strengthen creativity and knowledge to practice the five freedoms of OER in different contexts and educational spaces.

5.0 Final Considerations

The teaching material of the SOCC titled "OER: Education for the Future" observes the realization of the five freedoms of OER (retain, reuse, revise, remix, and redistribute) proposed by Wiley (2014). In the third edition, the correlation of the course contents with the competencies contemplated in the Open Educational Resources (OER) Competency Framework was made explicit, which are: familiarizing oneself with OER (D1), researching (D2), using (D3), creating (D4), and sharing (D5).

The SOOC titled "OER: Education for the Future", based on the epistemological foundations and characteristics of DBR, generates an iterative cyclical dynamic so that all those involved become co-responsible, ethically and aesthetically, for the results produced. The iterative cycles of the course are virtuous since they allow adaptation, remixing, or production of original OER. These may be redistributed as new pedagogical solutions and creations, while one of the prerogatives of DBR is the applicability of the results. Figure 6 systematizes some of the characteristics of the DBR implemented in the SOOC titled "OER: Education for the Future". In this schematization, we highlight the applied nature of DBR in research in emerging teacher education contexts as an improvement of Technological-Pedagogical Fluency to consolidate disruptive educational innovation.

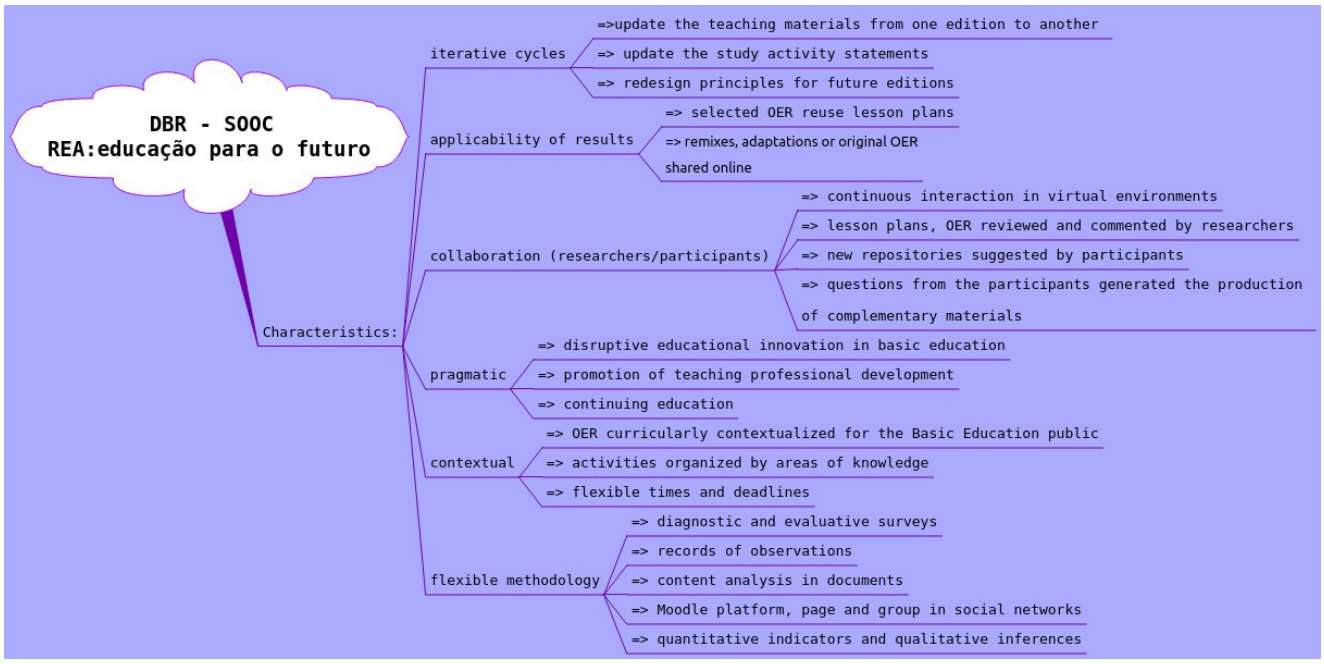

Figure 6. Characteristics of DBR applied to the SOOC titled "OER: Education for the Future"

The process carried out throughout the seventeen (17) editions is based on the conception of (co)authorship of OER and not only on reusing existing teaching materials. The flexible methodology and pragmatic assumption of DBR enable participants to collaboratively engage in the construction of professional knowledge that extrapolates the theme prioritized in the course. In this sense, the congruence between the theoretical-practical assumptions of DBR and Technological-Pedagogical Fluency (TPF) amplifies and enhances the creation of innovative educational solutions to the problems of concrete reality and with the collaboration of participants.

The team developed a theoretical understanding regarding DBR that shows that in educational processes aimed at technologies and, especially OER, design principles can be generic. By not being specific about the content or the technical components of languages, formats, platforms and tools, it is possible to optimize and contextualize the education of professionals according to their most emerging needs. In our study, design principles can be compiled such as: a) necessary curation of teaching materials in advance for refinement during iterative cycles; b) precise diagnoses that include the specificities for each level of teacher performance; c) study resources and practical activities that consider the most current public policies and curricular guidelines; d) collective activities that require extended time for interaction and socialization; e) participants' conceptual understandings that are more accurate when content is organized into small modules instead of linear sequences; f) schedules that must include the possibility of flexible deadlines; g) the necessity to address the ethical-aesthetic values of network authorship, freedom, openness and democratization of knowledge in all phases of DBR when the themes

deal with open education and OER.

Therefore, the foundations of DBR offer both a theoretical and practical contribution to studies and development of innovative solutions in the context of open education, especially when it comes to teacher education on Open Educational Resources (OER). It was clarified that the convergence of flexible methods compiling both quantitative and qualitative procedures generated the possibility of contextualization and pragmatic guidance throughout the phases and iterative cycles. This generates data for deeper analysis and, consequently, greater understanding and engagement for everyone involved. Therefore, DBR offers the epistemological foundations necessary for investment in improving the Technological-Pedagogical Fluency (TPF) of education professionals, which is essential for the sustainability of disruptive educational innovation mediated by Open Educational Resources.

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