ORIGINAL ARTICLE

MODELING AND ANALYSIS OF A HYPERDOCUMENT AS A PEDAGOGICAL SUPPORT TOOL IN HYBRID EDUCATION

Pablo João Canal da Costa[1]
Adriano Canabarro Teixeira[2]

ABSTRACT

This article presents the development of a hyperdocument prototype designed as a support tool for educators in the context of hybrid teaching. The research aimed to model and structure the hyperdocument using the well-established HTM technique, facilitating the understanding and implementation of hybrid teaching in an accessible and efficient manner. The methodology adopted is grounded in Design Science Research (DSR), which guided the systematic creation of the prototype. The results indicate that the hyperdocument offers a structured and organized solution, enabling educators to effectively integrate theory and practice in hybrid teaching. It is concluded that the prototype constitutes a promising tool for teacher training, promoting a more dynamic and interactive comprehension of the definitions and modalities of hybrid teaching.

Keywords: HTM technique. Continuing teacher education. Educational technologies.

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1. Universidade de Passo Fundo
2. Universidade de Passo Fundo

MODELAGEM E ANÁLISE DE UM HIPERDOCUMENTO PARA SUPORTE PEDAGÓGICO NO ENSINO HÍBRIDO

RESUMO

Este artigo apresenta o desenvolvimento de um protótipo de hiperdocumento como ferramenta de suporte para educadores no contexto do ensino híbrido. A pesquisa teve como objetivo modelar e estruturar o hiperdocumento utilizando a técnica HTM, uma abordagem consolidada na literatura, visando facilitar a compreensão e a aplicação do ensino híbrido de forma acessível e eficiente. A metodologia adotada baseia-se na *Design Science Research* (DSR), que orientou a criação do protótipo. Os resultados demonstram que o hiperdocumento oferece uma solução organizada e estruturada, permitindo aos educadores integrar teoria e prática no ensino híbrido. Conclui-se que o protótipo representa uma ferramenta promissora para a formação docente, possibilitando uma compreensão mais dinâmica e interativa das definições e modalidades do ensino híbrido.

Palavras-chave: Técnica HTM. Formação docente continuada. Tecnologias educacionais.

MODELADO Y ANÁLISIS DE UN HIPERDOCUMENTO COMO HERRAMIENTA DE APOYO PEDAGÓGICO EN LA EDUCACIÓN HÍBRIDA

RESUMEN

Este artículo presenta el desarrollo de un prototipo de hiperdocumento diseñado como herramienta de apoyo para educadores en el contexto de la enseñanza híbrida. La investigación tuvo como objetivo modelar y estructurar el hiperdocumento utilizando la técnica HTM, ampliamente consolidada en la literatura, con el fin de facilitar la comprensión y la implementación de la enseñanza híbrida de manera accesible y eficiente. La metodología adoptada se basa en el enfoque Design Science Research (DSR), que guió la creación sistemática del prototipo. Los resultados indican que el hiperdocumento ofrece una solución organizada y estructurada, permitiendo a los educadores integrar de manera efectiva la teoría y la práctica en la enseñanza híbrida. Se concluye que el prototipo constituye una herramienta prometedora para la formación docente, promoviendo una comprensión más dinámica e interactiva de las definiciones y modalidades de la enseñanza híbrida.

Palabras clave: Técnica HTM. Formación docente continua. Tecnologías educativas.

1. INTRODUCTION

Beginning in 2019, with the outbreak of the COVID-19 pandemic, Blended Learning (BL) gained prominence as a methodology that seeks to combine face-to-face and online education in an integrated manner, representing a new frontier in formal education (Souza & Mota, 2024) and a growing pedagogical trend in K-12 education (Duarte et al., 2023). This approach offers flexibility and personalization in learning by leveraging both direct interaction between students and teachers and access to a wide range of digital educational resources (Gedik, Kiraz, & Ozden, 2013; Chan & Quek, 2014; Moran, 2015; Kumar et al., 2021; Masadeh, 2021; Mintii, 2023; Kanwal, Zahid, & Afzal, 2023).

Despite these advantages, the implementation of BL poses significant challenges—ironically, often due to those very advantages. The broad spectrum of pedagogical strategies and digital resources available can make it difficult for educators to effectively integrate digital tools and practices with traditional classroom methods. A lack of familiarity with educational technologies, limited experience with digital pedagogical practices, and the absence of adequate resources and support can render this transition particularly complex. In this context, there is a growing need to provide teachers with supplementary instructional materials to support the adoption of this approach, offering guidelines, practical recommendations, and strategies for the successful implementation of Blended Learning.

Thus, hyperdocuments emerge as a powerful tool—a multimedia environment with didactic purposes—capable of enriching the educational experience by integrating text, video, audio, images, and interactive links into a cohesive and dynamic format (Mahdi, Naidu, & Kurian, 2019; Trust, Carpenter, & Green, 2022). As supplementary instructional resources, they allow for free and on-demand navigation, enabling educators to delve deeper into the topics of greatest interest or need, while still following a structured and content-rich resource.

In this regard, the present study seeks to address the following research question: How can the implementation of a hyperdocument prototype support the effective integration of theory and practice in Blended Learning, offering meaningful assistance to educators in the development and application of pedagogical strategies? This investigation is grounded in the hypothesis that the use of hyperdocuments as instructional materials may provide an interactive and accessible means of integrating and applying theoretical concepts within educational contexts, offering educators a practical and effective resource for Blended Learning.

Accordingly, a hyperdocument prototype was developed and analyzed as a support tool for educators, aiming to integrate the theory and practice of Blended Learning. The prototype was designed using the HTM technique, a well-established approach in the literature (Nemetz, 1995a), recognized for its ability to organize and structure knowledge in a clear and accessible manner. In this context, the tool is expected to assist educators in understanding the definitions, modalities, and applications of Blended Learning, thereby facilitating the implementation of pedagogical strategies and contributing to improved instructional effectiveness.

This study is organized into five sections, beginning with the present introduction. The following section presents the theoretical foundations that underpin the research. Next, the methodological framework is outlined, followed by the presentation and discussion of results, including the hyperdocument prototype and its various models. The paper concludes with final considerations.

2. THEORETICAL FRAMEWORK

This section discusses the key concepts that underpin the study: continuing teacher education, Blended Learning, and hyperdocuments.

2.1 Continuing Teacher Education

The adaptation and incorporation of new teaching methodologies require that teachers remain up to date in order to offer a teaching and learning process that meets the current needs of their students and of society. Ongoing professional development is essential to ensure that educators are equipped to address the challenges of emerging practices and to provide relevant and effective education.

In this regard, Silva and Guedes (2022) emphasize that the teaching profession demands continuous learning and professional development to expand, update, and reframe pedagogical practices in the face of their inherent challenges and complexities. These authors argue that entering the teaching profession also brings the need to build upon previously acquired knowledge, to seek out new understandings, and to refine them—thus making continuing education an opportunity to consolidate and reframe pedagogical practice (Silva & Guedes, 2022).

Furthermore, the National Education Guidelines and Framework Law (LDBEN) establishes, in the first paragraph of Article 62, that it is the joint responsibility of the federal government, the Federal District, states, and municipalities to promote initial and continuing teacher education, as well as professional development. The second paragraph of this article emphasizes that continuing teacher education may utilize distance education resources and technologies (Brazil, 1996). In this context, Morais and Souza (2020) highlight that, within the framework of continuing teacher education supported by distance education tools and technologies—as recommended by the LDBEN—the use of Blended Learning opens up a range of pedagogical possibilities in diverse and contextually relevant ways.

2.2 Blended Learning

Halverson et al. (2017) point out that Blended Learning (BL) is a relatively recent and continuously evolving field, with researchers still dedicating considerable effort to exploring its definition and identifying the most appropriate theories and models to guide their studies.

In general terms, BL is defined by Graham as a system that "combines face-to-face instruction

with computer-mediated instruction" (Graham, 2006, p. 41). The Christensen Institute, however, defines Blended Learning from the student's perspective, rather than from the instructor's point of view: "Blended learning occurs when a student learns partly in a supervised brick-and-mortar location away from home and partly through online delivery, with some element of student control over time, place, path, and/or pace" (Staker et al., 2011, p. 3).

Horn and Staker (2015) emphasize that BL is distinct from both fully online education and technology-enhanced instruction. In online learning and technology-enhanced settings, students typically follow standardized activities designed for the whole class. In contrast, in Blended Learning, students exercise some control over the timing, location, and pace of their learning.

This means that, in Blended Learning (BL), students have the freedom to decide when and where to study, as well as the ability to progress through the content at a pace that best suits their individual needs. In this regard, these authors laid a foundation that inspired further studies, such as that of Bacich, Tanzi Neto, and Trevisani (2015), who explore key concepts and common BL models: Rotation (station rotation, lab rotation, flipped classroom, individual rotation), Flex, and Enriched Virtual.

As can be observed, BL is characterized by its flexibility, allowing students to advance through content at their own pace. Caldeira and Vieira (2023) emphasize that the concept of BL should be broadened to encompass various strategies and dimensions of learning, taking into account an educational approach that integrates practices, spaces, individuals, technologies, and cultures, with the goal of enhancing knowledge construction.

Therefore, the concept of Blended Learning must be expanded to incorporate a variety of instructional methods and learning dimensions, combining practices, environments, people, technologies, and cultures to enrich the learning experience. Bozkurt (2022) argues that BL is a process that involves multiple approaches and is often accompanied by a complex and sometimes ambiguous terminology.

In this context, Bozkurt and Sharma (2022) define Blended Learning as the integration of face-to-face and online learning, aiming to combine the strengths of each modality while mitigating their limitations. This combination offers flexibility regarding time, space, learning path, and pace, and can be implemented through either sequential or parallel instructional designs.

It can be said that BL offers versatility to students by allowing them to choose the type of material to access according to their specific needs. This, in turn, enables lessons to be designed and structured in ways that are more aligned with their individual difficulties and demands. Personalization of instruction results from the opportunity to tailor content to the unique requirements of each student, thereby addressing their specific learning needs.

Moreover, BL combines the interpersonal interaction of face-to-face classes with the diversity of digital resources, providing a richer learning experience and potentially increasing student engagement and motivation. As a result, it expands opportunities for teaching and learning.

However, the implementation of Blended Learning faces significant challenges that impact

the student learning experience. Among the main challenges are planning and professional development, which require restructuring lessons, training educators, and adapting assessment methods—often resulting in an increased workload for teachers (Masadeh, 2021; Mintii, 2023; Gedik, Kiraz, & Ozden, 2013).

Another challenge is finding the right balance between face-to-face and online instruction, a task that requires continuous harmony between these modalities (Gedik, Kiraz, & Ozden, 2013). Additionally, it is essential to ensure adequate technological infrastructure, including the selection of appropriate digital platforms and ensuring access to technology for all stakeholders (Kumar et al., 2021; Mintii, 2023).

Student engagement is also a critical issue, as maintaining motivation in virtual environments presents a constant challenge (Souza, 2023). Finally, the complexity of the model and the lack of institutional support often hinder its successful implementation (Chan & Quek, 2014).

2.3 Hyperdocuments and Hyperobjects

A hyperdocument is a digital document with multimedia and interactive elements, such as text, images, videos, audio, and hyperlinks, which allow for nonlinear and personalized navigation, tailored to the user's needs (Bulegon et al., 2009). While the flexibility of hyperdocuments is an advantage, it can also lead to user disorientation, as users may not know where they are within the network or how to navigate to other points (Conklin, 1987). Rivlin, Botafogo, and Shneiderman (1994) further highlight cases in which users are unaware of their point of origin or what can be accessed from a given point.

A hyperobject can be defined as a term referring to an object to which actions and/or sets of information in the form of code blocks, text, words, images, sounds, functions, and actions are added, all accessible through specific references called hyperlinks, or simply links, in the digital realm (Pezzi, 2015). Expanding on this concept, Lima (2017) asserts that hyperobjects are multimedia objects composed of content and a hyperstructure for accessing it, representing interlinked multimedia and hypertextual information.

As presented by Nemetz (1995a), there are various techniques for modeling hyperdocuments. In this study, we specifically chose the Hypermedia Modeling Technique (HMT) due to its ability to reduce user disorientation and facilitate the identification of comprehensible structures that interlink the components of the application (Nemetz, 1995b).

The HMT assists in the creation of interactive, adaptive, and time-based hypermedia applications, offering advanced features such as temporal dependencies, search interfaces, access restrictions, and sophisticated hyperlinks (Specht & Zoller, 2000). Thus, the HMT modeling technique stands out by facilitating navigation and comprehension of hypermedia applications, reducing user disorientation. According to Nemetz (1995a), HMT utilizes four models to structure the application. Each of these models plays an important role in organizing and presenting information, ensuring that the hyperdocument achieves its goal of providing an intuitive and effective user experience.

These models are: i) the object model, ii) the hyperobject model, iii) the navigation model, and iv) the interface model.

Regarding the object model, Nemetz, Lima, and Borges (1995, p. 262-263) define it as "the one that describes the structure of objects within a domain (their identities, relationships with other objects, attributes, and operations) and aims to describe objects by capturing the semantics of the application domain." This system is identified according to classifications (essential characteristics), attributes (properties), relationships (connections), and operations (actions to be performed) specific to the domain, thus facilitating communication among the development team in understanding the system and its features, contributing to a more agile and assertive development process.

The hyperobject model is derived from the refinement of the object model, emphasizing the definition of new associations and classes that establish desired pathways; the identification of different media to be used; and the identification of abstract classes (Nemetz, Lima, & Borges, 1995). In other words, this model analyzes each class defined in the object model to ensure that all connections align with the intended conceptual model. It defines the desired path based on the object model by establishing new associations and classes, as well as identifying the media that will be available in the hyperdocument.

In the navigation model, the access structures are defined, and the links are determined so that navigation is intuitive, avoiding user disorientation and reducing cognitive overload, using menus, indexes, and guided walkthroughs (Falkembach, 2005). Furthermore, according to Nemetz, Lima, and Borges (1995, p. 267), each association is analyzed in terms of its cardinality and direction. The direction of the association—whether it is unidirectional or bidirectional—is a design decision made in the navigation model. In other words, the navigation model outlines the path to be followed by the user.

The interface model, on the other hand, must be compatible with the previous models and establishes the visual identity of the product. It consists of a set of elements that organize information and define user actions (Falkembach, 2005). In this model, it is determined how information will be displayed on the screen for the user, covering the organization of elements (layouts), the appearance of objects, and the overall visual identity.

3. METHODOLOGICAL APPROACH

This study is an applied research with a qualitative approach, focusing on the interaction between the hyperdocument prototype and educators using Blended Learning (Silva & Menezes, 2001). The research is descriptive, aiming to outline the characteristics of the presented prototype (Gil, 2002).

Regarding the procedures, we adopted elements of Design Science Research (DSR) as the epistemological and methodological foundation, with an emphasis on the development of artifacts in interdisciplinary contexts between Education and Computer Science (Pimentel, Filippo, & Santos,

2020). According to these authors, DSR aims to create artifacts to solve practical problems and generate new technical and scientific knowledge, recognizing the distinction between these types of knowledge, which are complementary. The methodological process of DSR that we followed was proposed by Peffers et al. (2007), and includes six stages: problem identification and motivation, definition of objectives for a solution, design and development, demonstration, evaluation, and communication.

The hyperdocument presented in this article is an educational multimedia environment designed to support continuous teacher training on the topic of "Blended Learning." Following the steps of the DSR method, we initially identified the challenges faced in Blended Learning and defined clear objectives to structure the multimedia environment model. The prototype was designed to be user-friendly and intuitive, promoting easy understanding of concepts and learning by educators. Its validation took place through presentations and discussions with colleagues and teachers, collecting feedback to identify issues and areas for improvement. Based on the feedback, we refined the platform to better meet the needs of users and analyzed its impact on learning. This process allowed us to develop an effective solution aligned with the demands of educators.

4. RESULTS AND DISCUSSION

In this section, we present the proposed hyperdocument. Following the HMT technique outlined earlier, we will discuss aspects of the object model, the hyperobject model, and the navigation model, as well as present some interface screens of the prototype developed.

4.1. Object Model

In the object model of the proposed hyperdocument on Blended Learning, illustrated in Figure 1, the concept of "Blended Learning" is the central element. Associated with it are the classes "General Concepts," "Pedagogical Strategy," "Online Part," and "In-person Part." This object model captures the meaning of the application, representing classes such as "General Concepts," "Pedagogical Strategy," "Online Part," and "In-person Part." These classes are essential for describing the different modalities of Blended Learning, combining in-person and online elements.

In the context of hypermedia, each class of the object model can be mapped to node types that organize and access educational content in an integrated and interactive manner. The associations between the classes in the model are seen as links or access structures, allowing for smooth and efficient navigation through the various components of Blended Learning. Thus, the "General Concepts" class includes definitions, benefits, challenges, and educational trends related to Blended Learning. The "Pedagogical Strategy" class presents different strategies for developing Blended Learning, categorized, through the inheritance concept, into four main types: Rotation, Flexible, À la Carte, and Enriched Virtual. The Rotation type is further subdivided into four subtypes: Flipped Classroom, Rotational Lab, Station Rotation, and Individual Rotation. To illustrate updates with the insertion of new pedagogical strategies into the model, we included a dotted line at the first level of the inheritance hierarchy, indicating, through the stereotype {incomplete}, that the model is not complete with all possibilities.

The classes "Online Part" and "In-person Part" represent the moments that occur virtually and in-person during the development of the pedagogical strategy. In addition, they are related to the classes "LMS Platform," "Interaction," and "Digital Learning Object," based on the understanding that these support the implementation of the activities proposed by the teacher, in accordance with the adopted pedagogical strategy.

The "Interaction" class represents synchronous or asynchronous modes in which activities can be carried out. For instance, a class can be synchronous, either in-person or virtual. Asynchronous interactions can take place through a forum or chat, for example, or can occur in face-to-face activities.

The "Digital Learning Object" class represents the possible digital resources that can be used by teachers and students, and is subdivided into: "Digital Educational Materials" and "Assessment." The "LMS Platform" class refers to the possible platforms that can be used to support the implementation of Blended Learning, providing support for conducting synchronous and asynchronous activities, object repositories, assignment submission, etc.

Finally, specifically related to the class "In-person Part," the class "Meeting" is subdivided into "Theoretical Practice" and "Laboratory Practice," and is also associated with the class "Learning Object." In in-person moments, the teacher can develop theoretical practical activities, such as a case study, or a laboratory practice. In these situations, learning objects can be used to support the development of the proposed activities.

Figure 1. Object Model of the Proposed Hyperdocument
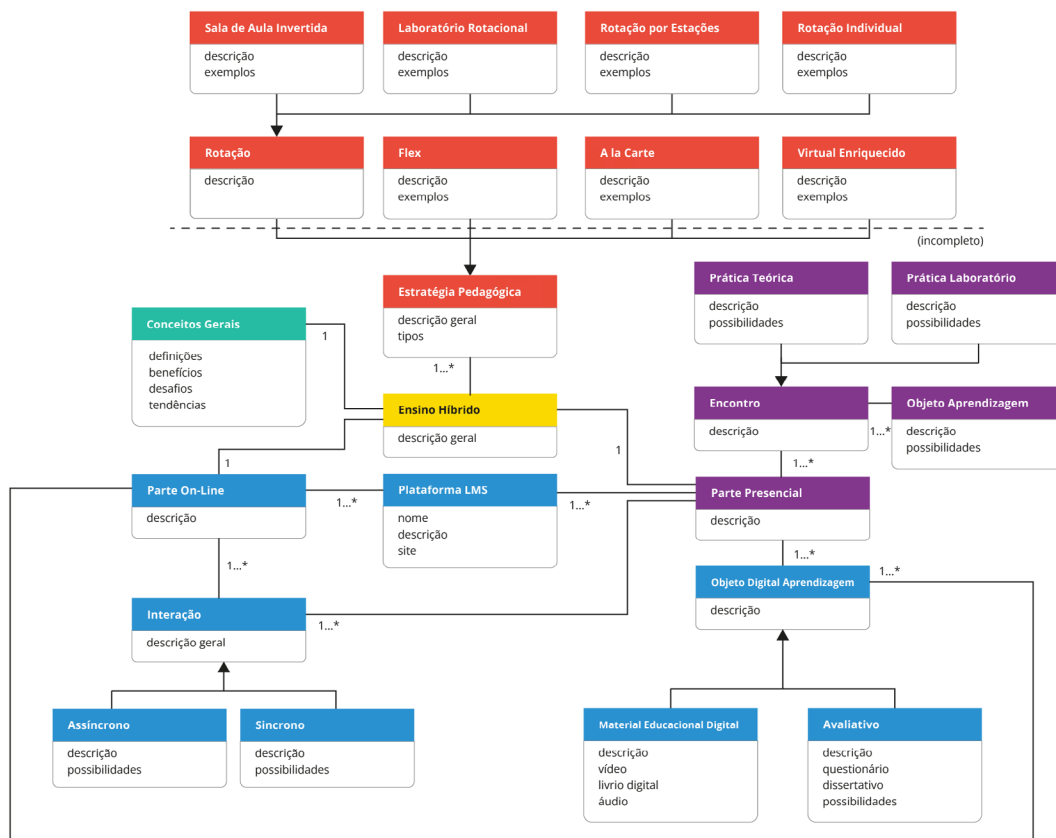
Source: Authors (2024).

4.2 Model of Hyperobjects

The hyperobject model refines the object model by incorporating specific classes to represent multimedia objects, such as Text, Video, Audio, Static Image, and Interactive Image (Kampff et al., 2005). Although no abstract or domain concept classes have been added, the model has been adjusted to enhance access to information through hyperlinks, transforming objects into hyperobjects, as described by Pezzi (2015). The transition to hyperobjects improves the integration of various media, facilitating access to information and providing a dynamic learning experience aligned with the contemporary use of integrated media.

Due to space limitations, we present only an excerpt of the diagram (Figure 2), where the class "Digital Educational Material" aggregates the multimedia objects used in the creation of the final hypermedia document, such as text, audio, static images, and video. The "Evaluative" class, on the other hand, aggregates the multimedia object of text.

Figure 2. Excerpt from the Hyperobjects Model of the Proposed Hyperdocument
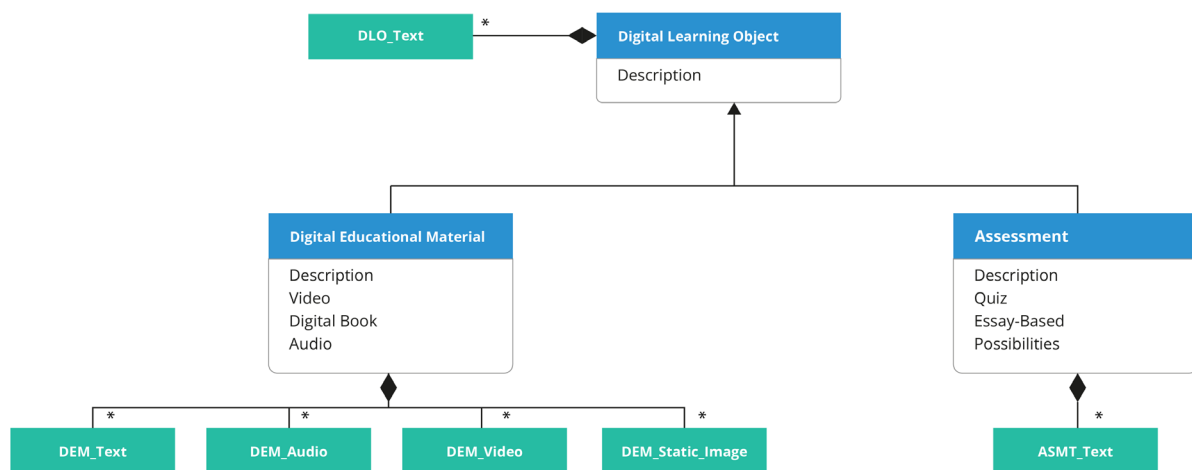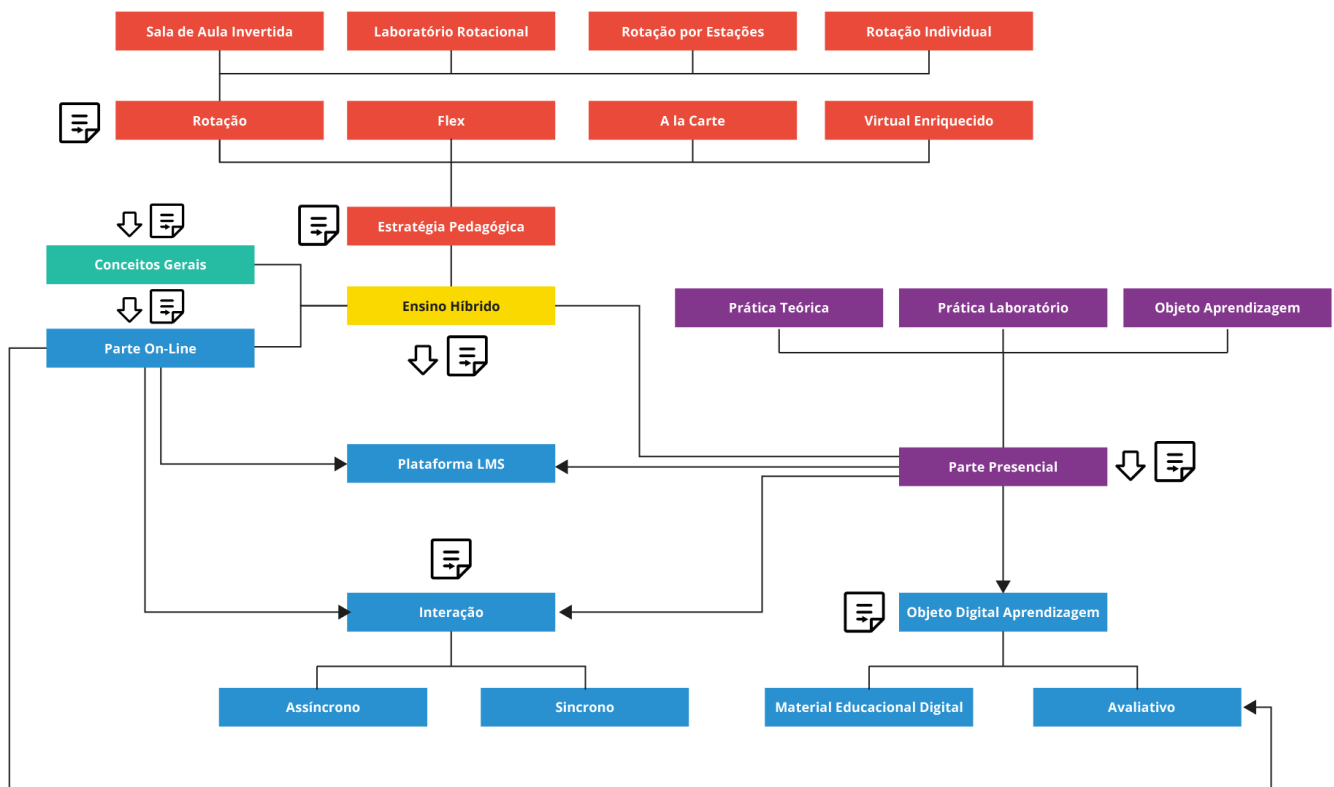

Source: Authors (2024).

4.3 Navigation Model

Figure 3 presents the navigation model of the hyperdocument proposed in this work. It features three entry points: Hybrid Learning, General Concepts, Online Section, and In-person Section. From each entry point, the available navigation method is through an indexed guided pathway, meaning that the user can select existing options related to the navigation context they are in. The connection links between the classes are generally bidirectional, with two-way navigation. When there is only one direction, the link indicates the destination represented by an arrow.

Through a detailed analysis of the associations and cardinalities, it was possible to identify the essential links and access structures needed to guide navigation. Thus, Figure 4 highlights three

distinct entry points, each offering an indexed guided route to facilitate the exploration of related content. With predominant bidirectional links, the user can navigate freely between different contexts and return when necessary, ensuring a smooth and intuitive navigation experience in the proposed Hybrid Learning hyperdocument.

Figure 3. Navigation Model

Source: Authors (2024).

4.4 Interface Model

Kampff et al. (2005) explain that the interface model describes how the user will perceive hypermedia objects. It is through the interface that users will interact with the hyperdocument using graphical elements (icons, buttons, images, and menus), rather than text commands.

In developing the interface model, it is essential to consider some basic principles aimed at providing a better user experience. For example: consistency (a consistent design throughout the interface helps users learn and use the resource more effectively); feedback (the interface should provide immediate feedback on the user's actions, such as color changes, sounds, or messages); simplicity (a simple and intuitive interface facilitates navigation and resource use). Furthermore, through the interface model, it is recommended to sketch the screen layout, indicating how many areas it will be divided into, the content of each area, and the visual identity that will be presented.

Figure 4 shows a screenshot from the prototype built in Google Sites, following the standard

layout of the hyperdocument. This is the main page, which allows access to four entry points: "General Concepts," "Online Part," "In-Person Part," and "Pedagogical Strategy," all indicated in the pathways and with access links. At the top, there are links to the entry points, regardless of the current subpage, ensuring consistent navigation and the possibility to explore new entry points.

Figure 4. Initial Interface of the Proposed Hyperdocument

HYBRID LEARNING

Hybrid learning, an innovative approach that combines the best of both face-to-face and digital environments, is transforming contemporary education. By integrating in-person classes with online activities, this methodology offers flexibility and personalization, addressing the diverse needs of students. Through hybrid learning, students have the opportunity to learn at their own pace, while teachers leverage advanced technologies to enrich content and engage learners more effectively. This combination not only prepares students for the challenges of the 21st century but also fosters continuous and adaptive learning.

TRACK 1
General Concepts

TRACK 2
Online Component

TRACK 3
In-Person Component

TRACK 4
Pedagogical Strategy
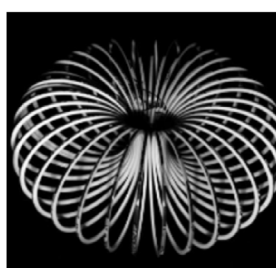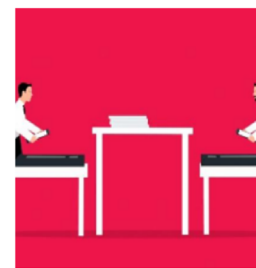
Source: Authors (2024).

Figure 5 presents the screen for Pedagogical Strategies, accessible from the entry point "Track 04" or via the menu in the top right corner. In constructing the prototype, we aimed to incorporate the use of both linear strategies (where content is organized according to a logical sequence of knowledge) and non-linear strategies (interconnected parts, clearly signaled), allowing the user to make their own choices and guide the construction of their own knowledge, as suggested by Bulegon et al. (2009).

Thus, our interface model defines how users interact with the hyperdocument using visual elements such as icons and buttons. To achieve this, we followed principles such as consistency, immediate feedback, and simplicity to ensure intuitive and efficient navigation. Additionally, the model specifies the screen layout and visual identity, exemplified by the prototypes in Google Sites, which provide coherent navigation between different sections of the document.

Figure 5. Track 4 - Pedagogical Strategies

PEDAGOGICAL STRATEGIES

Pedagogical strategies refer to the methods and techniques deliberately planned by educators to promote effective and meaningful learning. These strategies offer numerous benefits, such as increased student engagement, the development of critical skills (including critical thinking and collaboration), and the inclusion of diverse educational needs. Best practices involve the integration of educational technologies and the provision of ongoing, constructive feedback.

ROTATION	FLEX	À LA CARTE	ENRICHED VIRTUAL

Source: Authors (2024).

5. FINAL CONSIDERATIONS

This study was driven by the growing relevance of Hybrid Learning (HL) as an innovative approach in contemporary education. Our main objective was to develop and analyze a hyperdocument prototype that not only supported but also enriched the continuous training of educators, facilitating the effective integration of theory and pedagogical practice within the context of HL.

The results confirmed that the hyperdocument, by integrating multimedia and interactive resources, serves as a practical and accessible tool for educators. It significantly contributes to the organization, access, and interaction with information, meeting the demands of the digital age and expanding educational possibilities. Innovations in the HTM method, such as the use of colors to enhance visualization and the introduction of incompleteness indicators, were essential in improving the clarity and effectiveness of the proposal.

Furthermore, the development experience highlighted that hyperdocuments can transform the way educators learn and, consequently, plan and implement pedagogical strategies, enhancing their actions, directly impacting student learning, and aligning with the demands of the current digital culture. Mastering methodologies for producing digital educational resources, such as the HTM model, seems to be an essential competency for contemporary teaching practice. Despite the positive results, it is important to recognize that the lack of practical application limits the direct assessment of the prototype's impact in real-life pedagogical support situations.

Therefore, for future research, it is proposed to investigate educators' perceptions of the applicability of the prototype in real contexts, aiming to evaluate its effectiveness, identify opportunities for improvement, and expand its use to different educational settings. In this way, the hyperdocument emerges as a promising, flexible, and interactive tool, capable of contributing to the ongoing training of teachers, the enhancement of teaching practices, and the integration of new technologies in education.

REFERENCES

BACICH, L.; TANZI NETO; A.; TREVISANI, F. M. **Ensino híbrido**: personalização e tecnologia na educação. Porto Alegre: Penso, 2015.

BOZKURT, A. A retro perspective on blended/hybrid learning: systematic review, mapping and visualization of the scholarly landscape. **Journal of Interactive Media in Education**, [*S. l.*], v. 22, n. 1, p. 1-15, 2022.

BOZKURT, A.; SHARMA, R. C. In pursuit of the right mix: blended learning for augmenting, enhancing, and enriching flexibility. **Asian Journal of Distance Education**, [*S. l.*], v. 16, n. 2, p. 1-6, 2022.

BRASIL. **Lei nº 9.394, de 20 de dezembro de 1996**. Estabelece as diretrizes e bases da educação nacional. Brasília: Presidência da República, 1996.

BULEGON, A. M. *et al.* Design of pedagogical material with hyperdocuments Technologies. *In*: WORLD CONFERENCE ON COMPUTERS IN EDUCATION, 9., 2009, Bento Gonçalves. *Anais* [...]. Bento Gonçalves: [*s. d.*], 2009.

CALDEIRA, E. M. V.; VIEIRA, F. M. S. As concepções de ensino híbrido na educação brasileira: uma revisão sistemática da literatura. **Revista Ibero-Americana de Estudos em Educação**, Araraquara, v. 18, 2023.

CHAN, R. H.; QUEK, C. Benefits, challenges and strategies of implementing blended learning in tertiary institutes. **International Journal of Social Media and Interactive Learning Environments**, [*S. l.*], v 2, n. 3, p. 285-300, 2014.

CONKLIN, J. Hypertext: an introduction and survey. **IEEE Computer**, New York, v. 20, n. 9, p. 17-41, 1987.

DUARTE, D. S. *et al*. Ensino híbrido como nova tendência pedagógica na educação básica. *In*: Editora Científica Digital (Org.). **Open Science Research X**. Guarujá: Científica Digital, 2023. p. 982-1002.

FALKEMBACH, G. A. M. Concepção e desenvolvimento de material educativo digital. **Revista Novas Tecnologias na Educação**, Porto Alegre, v. 3, n. 1, 2005.

GEDIK, N.; KIRAZ, E.; OZDEN, M. Y. Design of a blended learning environment: Considerations and implementation issues. **Australasian Journal of Educational Technology**, [*S. l.*], v. 29, n. 1, p. 1-19, 2013.

GIL, A. C. **Como elaborar projetos de pesquisa**. 4. ed. São Paulo: Atlas, 2002.

GRAHAM, C. Blended learning systems. *In*: GRAHAM, C. (Ed.). **The handbook of blended learning**. Hoboken: Wiley E Sons, 2006. p. 3-21.

HALVERSON, L. R. *et al*. Blended learning research in higher education and k-12 settings. In: SPECTOR, M.; LOCKEE, B.; CHILDRESS, M. (Eds.). **Learning, design, and technology**. [*S. l.*]: Springer, Cham. 2017.

HORN, M. B.; STAKER, H. **Blended**: usando a inovação disruptiva para aprimorar a educação. Porto Alegre: Penso, 2015.

KAMPFF, A. J. C. *et al*. Um hiperdocumento para introdução à geometria plana. **Revista Novas Tecnologias na Educação**, Porto Alegre, v. 3, n. 2, 2005.

KANWAL, A.; ZAHID, A.; AFZAL, A. Investigating the benefits and challenges of blended learning approaches at the university level. **Qlantic Journal of Social Sciences and Humanities**, [*S. l.*], v. 4, n. 3, p. 76-89, 2023. Disponível em: https://europub.co.uk/articles/investigating-the-benefits-and-challenges-of-blended-learning-approaches-at-the-university-level-A-733399. Acesso em: 29 abr. 2025.

KUMAR, A. *et al*. Blended learning tools and practices: a comprehensive analysis. **IEEE Access**, v. 9, p. 85151-85197, 2021.

LIMA, J. V. Webmedia: história, conteúdo e mídia. *In*: BRAZILIAN SYMPOSIUM ON MULTIMEDIA AND THE WEB, 23., 2017. **Anais** [...]. [*S .l.*], 2017.

MAHDI, Z.; NAIDU, V. R.; KURIAN, P. Analyzing the role of human computer interaction principles for e-learning solution design. *In*: AMERICAN UNIVERSITY IN THE EMIRATES INTERNATIONAL RESEARCH CONFERENCE, 1., 2017, Dubai. **Anais** [...]. Dubai: Springer Cham, 2019.

MASADEH, T. S. Y. Blended learning: issues related to successful implementation. **International Journal of Scientific Research and Management**, [*S. l.*], v. 9, n. 10, 2021.

MINTII, I. S. Blended learning for teacher training: benefits, challenges, and recommendations. **Educational Dimension**, [*S. l.*], v. 9, 2023.

MORAIS, A. P. M.; SOUZA, P. F. Formação docente continuada: ensino híbrido e sala de aula invertida como recurso metodológico para o aprimoramento do profissional de educação. **Devir Educação**, [*S. l.*], Ed. Esp., p. 10-32, 2020.

MORAN, J. Educação híbrida: um conceito-chave para a educação, hoje. *In*: BACICH, L.; TANZI NETO, A.; TREVISANI, F. de M. (Orgs.). **Ensino Híbrido**: personalização e tecnologia na educação.

Porto Alegre: Penso, 2015. p. 40-65.

NEMETZ, F. **HMT**: Modelagem Projeto de Aplicações Hipermídia. 1995. Dissertação (Mestrado em Ciência da Computação) — Universidade Federal do Rio Grande do Sul, Porto Alegre, 1995a.

NEMETZ, F. Uma técnica para modelagem de aplicações hipermídia e um exemplo de uso. *In*: SEMINÁRIO INTEGRADO DE SOFTWARE E HARDWARE. 1995, Canela. **Anais** [...]. Porto Alegre: Instituto de Informática da UFRGS, 1995b.

NEMETZ, F; LIMA, J. V.; BORGES, A. C. Uma técnica para modelagem de aplicações hipermídia e um exemplo de uso. *In*: CONFERÊNCIA LATINO-AMERICANA DE INFORMÁTICA, 21., 1995, Canela. **Anais** [...]. Canela: Sociedade Brasileira de Computação, 1995.

PEFFERS, K. *et al*. A design science research methodology for information systems research. **Journal of management information systems**, [*S. l.*], v. 24, n. 3, p. 45-77, 2007.

PEZZI, R. P. Ciência aberta: dos hipertextos aos hiperobjetos. *In*: ALBAGLI, S.; MACIEL, M. L.; ABDO, A. H. (Orgs.). **Ciência aberta**. Rio de janeiro: IBICT, UNIRIO, 2015. p. 169-200.

PIMENTEL, M.; FILIPPO, D.; SANTOS, T. M. Design science research: pesquisa científica atrelada ao design de artefatos. **RE@D - Revista de Educação a Distância e Elearning**, [*S. l.*], v. 3, n. 1, 2020.

RIVLIN, E; BOTAFOGO, R; SHNEIDERMAN, B. Navigating in hyperspace: designing a structure-based toolbox. **Communications of the ACM**, New York, v. 37, n. 2, p. 87-96, 1994.

SILVA, E. L.; MENEZES, E. M. **Metodologia da pesquisa e elaboração de dissertação**. 3. ed. Florianópolis: UFSC, 2001.

SILVA, L. C.; GUEDES, N. C. A Formação continuada de professores e a escola como lócus de aprendizagem. **Linguagens, Educação e Sociedade**, [*S. l.*], v. 25, n. 49, 2022.

SOUZA, A. A. **Avaliação da influência de um assistente virtual no perfil de engajamento de estudantes em ambientes EaD**. 2023. Dissertação (Mestrado em Engenharia de Computação) – Programa de Pós-graduação, Acadêmica em Engenharia de Computação da Universidade de Pernambuco, Recife, 2023.

SOUZA, A. S. M.; MOTA, M. A. Híbrido: a nova fronteira do ensino formal. **Revista Docentes**, Fortaleza, v. 9, n. 27, p. 49-53, 2024.

SPECHT, G.; ZOLLER, P. HMT: Modeling Temporal Aspects in Hypermedia Applications. *In*: INTERNATIONAL CONFERENCE WAIM, 1., 2000, Shanghai. **Anais** [...]. Shanghai, 2000.

STAKER, H. C. *et al.* **The rise of K-12 blended learning**: profiles of emerging models. Innosight Institute. 2011.

TRUST, T.; Carpenter, J.; GREEN, T. Understanding teacher learning about hyperdocs through the lens of professional learning networks. **Issues and Trends in Learning Technologies**, [*S. l.*], v. 10, n. 2, 2022.