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Art and technology in Portugal:

Chronologies, archaeologies, symbologies

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Abstract: This article aims to present Portuguese electronic literature, understood through the lens of the relationship between art and technology, by adopting three integrated perspectives: chronological, archaeological, and symbolic. Initially, it presents a chronology that identifies the three generations of electronic literature proposed by Flores, from pre-World Wide Web experiments to the use of social networks and mobile applications. Subsequently, an archaeological perspective is presented, discussing the challenges inherent in digital preservation and describing methods that maintain the accessibility of these works in the face of technological obsolescence. Finally, a symbolic analysis is suggested, centered on the metaphor of water as a cross-sectional element that reflects the transformations and flows signaled by the practices of electronic literature. The article includes a varied corpus of selected works that highlight the media, cultural, and technological diversity of the phenomenon. It concludes by highlighting the potential role of electronic literature in promoting digital literacy, proposing that it can be a decisive pedagogical tool in the current post-digital era.

Keywords: Electronic Literature; Digital Preservation; Digital Literacy.

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Introduction

The relationship between art and technology plays a central role in the evolution of electronic literature in Portugal, opening new pathways for the creation and reception of literary works in a digital environment. From the early experiments with computers in the 1950s to the present day, electronic literature reflects the convergence of emerging technological tools and artistic practices, offering multimodal and interactive experiences that challenge traditional forms of reading and writing. This inherently digital phenomenon invites reflection on its cultural, media, and technological implications.

This chapter aims to explore Portuguese electronic literature through three interconnected axes: chronologies, archaeologies, and symbologies. These axes provide a comprehensive perspective that allows for the mapping and understanding of creative practices and the challenges related to the preservation of electronic literature in a context of constant technological evolution.

In the first axis, chronologies, we present and describe the three generations of electronic literature, following Leonardo Flores' proposal. These generations span early experiments with mainframe computers, the global expansion of the web, and the collaborative platforms and social networks of today. In the archaeologies axis, we discuss strategies for preserving these digital works, emphasising the importance of considering the specificities of each generation's creations. Finally, in the symbologies axis, we use the metaphor of water to illustrate how technological transformations and flows shape the evolution of electronic literature, from the rigidity of ice to the volatility of vapour.

Drawing on a diverse corpus of works, we highlight examples that showcase the media richness and cultural depth of Portuguese electronic literature. These works enable an understanding of both the technical aspects and the symbolic meanings associated with this hybrid form of literary expression. We also argue that electronic literature holds significant potential to promote digital literacy, offering new ways of interacting with texts and fostering essential digital skills in the post-digital era.

Thus, this chapter seeks not only to portray the evolution of electronic literature in Portugal but also to reflect on its role as a pedagogical tool and a cultural element in constant adaptation.

1. Electronic Literature: dialogue between art and technology

The dialogue between art and technology has a prolific and diverse history. Packer and Jordan (2001), when framing and defining multimedia, suggest that to understand the integration of languages in immersive and interactive environments, we must go back to the multisensory experiences of the cave paintings in Lascaux, dating back approximately 17,000 years. Much later, though still before digital technologies, the authors identify other origins of multimedia in opera, seen as a total work of art (gesamtkunstwerk) by Richard Wagner in the 19th century.

Indeed, technology has always played a fundamental role in the development of artistic expression, opening up possibilities for artists to explore new mediums and techniques. In the transition to the 20th century, with the expansion of the phonograph and photography, and their subsequent integration into cinema, the combination of artistic forms and technologies into hybrid forms of expression (Packer and Jordan, 2001) became even more relevant. More recently, the emergence of the computer and the internet has provided a set of tools that have profoundly altered the creation and circulation of art. It is within this context of ongoing dialogues between art and technology that electronic literature (hereafter, e-literature) emerges.

The field of e-literature is vast and dynamic, evolving as authors creatively explore and adopt new technologies. In this sense, e-literature challenges and transcends definitions, which must be constantly renewed to capture and reflect this transformation.

Pedro Barbosa (1977, 1980, 1988) is one of the first authors to reflect in a sustained way on the new textual forms that emerged from the creative symbiosis between humans and machines, initially referring to them as cybernetic literature and later as cyberliterature[1]. For Barbosa, texts generated with the computer are indeterminate, involving "dynamic, automatic, variational, reticular, or interactive generative structures" (Barbosa, 2006, p. 16). In 1996, Pedro Barbosa founded CETIC - Center for Studies on Computer Text and Cyberliterature (CETIC, n.d.) at the Universidade Fernando Pessoa in Porto. This transdisciplinary research center, focused on Computer-Generated Literature, led Barbosa to conclude that cyberliterature involves using the computer as an "open machine" or "semiotic machine," causing "a profound alteration in the entire communicational circuit of literature, from the creation to the circulation of the message" (Barbosa, 1998).

Espen Aarseth (1997) examined these forms of cybertext as ergodic literature, explaining that certain texts are structured through mechanisms that allow the reader to configure various pathways. The ergodicity of cybertext defines and circumscribes the majority of e-literature works. However, its material and aesthetic antecedents can be identified in concrete and visual poetry from the 1950s onwards, or even in the Baroque labyrinths of the 17th and 18th centuries, among others[2], according to Aarseth (1997).

[1] In the 1950, Max Bense (1950), Alan Turing (1950), Christopher Strachey (1954), and Theo Lutz (1959) wrote about generative aesthetics, computing, thinking machines, and stochastic texts, respectively. In the following decade, Nanni Balestrini (1962), António Aragão (1963), Theodor Holm Nelson (1965), E. M. de Melo e Castro (1965), and Joseph Weizenbaum (1966) explored the concepts of hypertext and hypermedia, combinatorial poetry, and artificial intelligence. However, it was only in the 1970s, with Robin Shirley (1972), James Richard Meehan (1976), and Pedro Barbosa (1977), that a theory of computational text truly close to what we now consider e-literature was developed.

[2] This view supports the approach of the Digital Archive of PO.EX (Torres, 2005), which identifies and recognizes as the antecedents of digital poetry a series of remote idealizations and realizations ranging from the Baroque to Futurism. In its proposed taxonomy, the Archive includes Digital Poetry as a genre of experimental literature, defining it as a "[f] orm of poetry that uses the potential of the computer as a creative machine, thus promoting a symbiosis between the artist and the machine, and based on the construction of combinatory, random, multimodal, or interactive algorithms." This open-access repository collects, classifies, and preserves hundreds of works of Portuguese e-literature: https://po-ex.net/tag/poesia-digital/.

At the close of the 20th century, the foundation of the Electronic Literature Organization (ELO) in 1999 by Scott Rettberg, Robert Coover, and Jeff Ballowe marked a significant development, aiming "[to] facilitate and promote the writing, publishing, and reading of literature in electronic media" (ELO, n.d.). The ELO provides a comprehensive definition that highlights the dialogues and symbioses mentioned earlier: "work[s] with an important literary aspect that takes advantage of the capabilities and contexts provided by the stand-alone or networked computer" (ELO, n.d.). This definition, requested by the ELO from a committee led by Noah Wardrip-Fruin, was later revisited by N. Katherine Hayles in "Electronic Literature: What is it?", where she explains that an e-literature work is "a first-generation digital object created on a computer and (usually) meant to be read on a computer" (Hayles, 2007). Thus, e-literature is natively digital: it is created and read within a technological context necessary for its existence and replication.

Aligned with these definitions are the proposals by Bouchardon (2016), Heckman and O'Sullivan (2018), Rettberg (2019), Flores (2021), and Berens et al. (2022a).

Serge Bouchardon distinguishes between digital literature and digitized literature, emphasizing that "[d]igital literature uses the affordances of the computer to dynamically render the story. (...) Digital literature is algorithmic. It changes as the reader engages it" (Bouchardon, 2016, p. 3). This distinction highlights the interactive and mutable nature of digital literature, contrasting with traditional literature, even when digitized, and underscores the importance of algorithms in creating unique experiences for each reader. Additionally, Davin Heckman and James O'Sullivan remind us that "[e]lectronic literature, essentially, must be electronic and literary" (Heckman & O'Sullivan, 2018).

This definition emphasizes that e-literature must integrate and balance different elements, ensuring that technology enhances the literary experience without compromising its poetic and/or narrative essence.

Scott Rettberg proposes that "electronic literature is most simply described as new forms and genres of writing that explore the specific capabilities of the computer and network – literature that would not be possible without the contemporary digital context" (Rettberg, 2019, p. 2). Thus, e-literature not only utilizes technological capabilities but also depends on them, creating genres and forms that would be unthinkable outside the current digital context.

In comparison, Leonardo Flores defines e-literature as "a writing-centered art that engages the expressive potential of electronic and digital media" (Flores, 2021, p. 27).

This definition values the exploration of the expressive potential of digital media within a writing-centered art form, expanding the creative possibilities of the media.

Additionally, the editors of the fourth volume of the Electronic Literature Collection (Berens et al., 2022a) propose that in e-literature, literary qualities are co-produced by human and algorithmic interaction. For the authors, the formal innovation triggered by technology is related

to conceptual innovations that result in transformative experiences for readers. This approach reinforces the co-production between humans and algorithms.

As evidenced by this brief initial overview[3], e-literature encompasses a broad range of aesthetic forms, fostering a convergence that transcends traditional conceptions of textuality. There is a dialogue between two layers: a computational layer and a cultural and literary layer. This transcoding (Manovich, 2001) involves the sophistication of cultural and media codes through computational codes, and vice versa.

For all these reasons, e-literature presents strong educational potential. Focusing on educational approaches and principles, it serves as a tool that can aid in the development of interdisciplinary teaching practices, promoting digital literacy. It can be seen as a critical device that engages readers with the materiality of media, raising awareness of the current distributed media ecology.

2. Approaches and Methods

2.1 Chronology: Generations and History

To identify distinct moments in the evolution of e-literature and how each moment invokes different archeologies and symbolisms, we turn to Leonardo Flores (2021), who proposes three generations of e-literature. In his proposal, Flores highlights how each generation reflects the interaction between art and technology in a unique way, redefining the literary experience in different historical contexts. [4]

The first generation corresponds to a phase of experimentation with electronic media from the 1950s until the popularization of the World Wide Web (c. 1993), during a period when access to computers was limited, resulting in a small number of practitioners. As Flores (2021) notes, e-literature distribution during this phase primarily occurred through physical media such as floppy disks, CD-ROMs, and paper prints, which limited the audience reached. This generation produced experimental works generally based on specific hardware and software, including genres like computational poetry, algorithmic and generative art, and computer-generated literature.

Flores (2021) explains that the advent of the World Wide Web marked a paradigm shift and facilitated growth in the creation and dissemination of e-literature, initiating what he terms the

[3]In addition to the pioneering studies by Aragão, Melo e Castro, Barbosa, and Pestana, mentioned throughout the article, it is important to highlight that other authors also wrote about the subject, even if only in brief notes such as prefaces and reviews, including Salette Tavares, Herberto Helder, Fernando Namora, and Ana Hatherly. Additionally, more developed studies have been conducted in doctoral theses by Pedro Reis, Álvaro Seiça, Fernanda Bonacho, Diogo Marques, and Ana Marques; in books and monographs by José Augusto Mourão and Manuel Portela; and in articles by Rui Torres, Daniela Côrtes Maduro, Diogo Marques, Bruno Ministro, and Sandra Guerreiro Dias. The following readings are recommended, which include notes on the evolution of cyberliterature in Portugal: Reis (2011), Portela (2013), Funkhouser (2014), Seiça (2015a), Torres and Marques (2020), and Torres and Ministro (2021).

[4]Flores' (2021) proposal on the generational division of e-literature aligns well with the concept of generational trends described by Nick Montfort (2018), which includes the phases of Pre-Web, Web, and Post-Web. Worksworks generally based on specific hardware and software, including genres like computational poetry, algorithmic and generative art, and computer-generated literature.

second generation. This generation began around 1995 and continues to the present. Programs such as Flash and Director, now discontinued or obsolete, as well as open languages like HTML and JavaScript, were essential tools for e-literature creation by this generation of authors and artists, allowing the development of customized interfaces. The second generation contributed works specifically for the web, utilizing its interactive capabilities, which led to genres such as hypermedia poetry and fiction, multimedia and interactive narratives, interactive webcomics, and computer-animated poetry (Flores, 2021).

Finally, starting from 2005, Flores (2021) suggests the onset of a third generation, with e-literature works based on widely adopted platforms and applications, as well as mobile apps and social web API services, resulting in massive production and audience engagement. Multimedia authoring software has migrated to platforms that allow near-instant editing of texts, images, sounds, animations, and videos, as well as facilitating the sharing of these contents. Flores (2021) argues that these third-generation works align with the poetics of contemporary digital culture, shifting focus from originality and difficulty to circulation in the form of remixes and derivations within participatory culture logic. The genres of e-literature that emerged with this generation include literary forms that use games, bots, GIFs, and memes to convey literary content, exploring the capabilities of social networks and collaborative platforms.

2.2 Archaeology: Preservation and Documentation

Each of the historical forms of e-literature mentioned, with its specific genres, presents distinct challenges in terms of preservation. The e-literature landscape—networked computing—is in constant transformation, resulting in a phenomenon of continuous metamorphosis and instability. Therefore, strategies for preserving digital information are essential to prevent technologies from becoming obsolete or discontinued.[5]

Digital preservation refers to the activity of creating a copy of specific digital information to a new medium when that information becomes obsolete and inaccessible (Lee et al., 2002, p. 94), ensuring that the information can be updated and processed in the future (Lee et al., 2002, p. 95).

The ELO has an initiative called PAD - Preservation, Archiving, and Dissemination, whose first report, "Acid-Free Bits," prepared by Nick Montfort and Noah Wardrip-Fruin and published as open access (Montfort & Wardrip-Fruin, 2004), presents the author and research community with a set of best practices aimed at keeping e-literature readable and accessible. The authors consider three main preservation strategies—technology preservation, emulation, and migration—which we will summarize.

Preservation – In this strategy, original hardware and software are maintained to run old programs. While effective, this option is costly and complex due to the need to conserve equipment and systems without updates. This method allows visitors to interact with works as they were originally presented.

[5] For a detailed analysis of these processes, see Torres ([2011]), where specific proposals for the preservation and dissemination of Portuguese e-literature are presented.

Emulation – This approach reproduces old programs on modern hardware through emulators, using virtualization tools to run obsolete software on current computers. However, the continuity of emulators depends on ongoing interest in the original platforms and also requires the preservation of the emulators themselves.

Migration – In this approach, old programs are converted to modern formats, preserving, as much as possible, the original data. This technique can result in varying degrees of fidelity and may introduce new problems, functioning as a translation or adaptation. However, migration can also stimulate innovative solutions to the challenges that arise during the process.

Although this model remains operational and aligned with best practices, its formulation without consideration of the third generation of e-literature necessitates an updated proposal. Thus, we propose three preservation mechanisms tailored to each generation: Hardware Preservation, Digital Preservation, and Network Preservation.

Hardware Preservation – This strategy corresponds to Montfort and Wardrip-Fruin's (2004) proposal, involving the maintenance of original hardware and software. The examples of e-literature we will present include two distinct subcategories: the first subcategory includes mainframes where old programming languages can run, as well as all related physical apparatus—punched cards, reels, program descriptions, and printed results on paper. The second subcategory covers works developed for home computers, such as those created for the ZX Spectrum and their respective cassette tapes.

Digital Preservation – What Montfort and Wardrip-Fruin referred to as emulation can be understood here as digital preservation. We should consider two distinct forms of digital preservation: Web Archiving, which includes capturing snapshots of web pages and interactive interfaces, incorporating services like the Internet Archive and Webrecorder; and Web Environment Emulation, which uses old browser emulators to run web works on modern browsers, such as Oldweb.today, mimicking old versions and maintaining the original experience. [6]

Network Preservation – This category is necessary because third-generation works adopt proprietary networks and platforms, whose source code is not available and is rarely documented. This strategy involves using forms of Social Media and Platform Capture, recording data and interactions on social networks through tools like ArchiveSocial, Twarc (for Twitter), and Archive-It; Containerization, with tools like Docker and Kubernetes, which encapsulate digital works in containers with all necessary dependencies; and Automated Migration, which allows the automation of the migration process to contemporary formats and environments, ensuring ongoing compatibility and accessibility. [7]

Additionally, Montfort and Wardrip-Fruin (2004) recommend adopting a holistic perspective, which involves a systematic approach to proactively document and archive works. This includes

[6] For information on digital preservation, archiving, and web environment emulation, see Pennock (2013) and Kaltman et al. (2014).
[7] For information on digital preservation, archiving, and web environment emulation, see Pennock (2013) and Kaltman et al. (2015).

the distribution of source code and the comprehensive recording of the creation process. Therefore, the preservation of e-literature requires a pedagogical approach that encompasses knowledge of metadata and essential information to assist future archivists in the interpretation and proper storage of works. We highlight this complementary strategy as extensive documentation, which creates conditions for the future recreation or emulation of the works.

In this vein, it is important to consider recontextualization strategies that allow for the adaptation or simulation of old works, such as the retextualizations carried out by the PO.EX Digital Archive on the works of Pedro Barbosa, E. M. de Melo e Castro, and Antero de Alda. Although recreation does not represent the original work in a strict sense, it serves to preserve the essence and content of the works, making them accessible to new audiences. Thus, we might argue that remixing acts as a complementary form of preservation.

2.3 Symbology: Metaphors and Meanings

A third approach to organizing the selected e-literature corpus involves analyzing the symbologies of water.[8] We believe this approach facilitates understanding the different generations of e-literature and reflects distinct preservation practices. Additionally, the themes of the selected works are also associated with water.

Water transitions between solid, liquid, and gaseous states, symbolizing transformation, metamorphosis, and regeneration (Chevalier & Gheerbrant, 2010, p. 41). These fluid characteristics can be used to address the generations and methods of e-literature preservation, reflecting the continuous evolution and adaptation of works over time. Given its transient nature, water represents a paradox of permanence: despite constantly changing and transforming, it is still perceived as water. This paradox of simultaneous impermanence and permanence metaphorically reflects the transient and emergent condition of e-literature.

Therefore, let us consider the three states of water—solid, liquid, gaseous; or ice, liquid water, vapor—and their symbolic meaning to understand the relationships and dialogues between art and technology, between culture and code, in e-literature.

Ice, as the solid state of water, symbolizes rigidity and stillness (Chevalier & Gheerbrant, 2010). It represents stability and permanence, serving as a metaphor for conservation. It preserves water in an immutable state, temporarily maintaining its integrity.

In the context of e-literature, ice can be seen as a metaphor for the preservation of hardware and software from the first generation of e-literature, kept unchanged to ensure the authenticity of the original experience. Just as ice preserves water in an unaltered state, hardware preservation seeks to maintain the integrity of digital literary works.

[8] Torres and Ferreira (2022) analyze the project *O homem que queria ser água* by António Abernú, focusing on the work's transpositions that blur the boundaries between different media. The authors use the different states of water as a metaphor to explore how transmedia narratives traverse various states. This approach adopts and expands on that model, reusing it to deepen the analysis of other examples of Portuguese e-literature, now articulated with the three generations and three distinct forms of preservation mentioned.

In its liquid form, water symbolizes the ability to travel and transport. According to Zygmunt Bauman (2000), the liquid state characterizes modernity, reflecting the role of the ephemeral and momentary in human experience, which is dynamic and ever-changing. Thus, liquid water represents adaptability and transition.

The fluid state of liquid water characterizes the second generation of e-literature, where interactive and multimedia works are navigated on the web, providing a dynamic and ever-changing experience. Liquid water symbolizes adaptability and transition, reflecting the nature of digital works that mold to customized interfaces and emerging technologies. Thus, liquid water relates to the digital preservation of works from this generation.

Finally, we observe a transition from the liquid to the gaseous state, as evidenced by metaphors related to cloud computing, which provides ubiquitous access to distributed network resources. Water vapor, being volatile and unstable, reflects the ephemeral and distributed nature of the digital age, marked by adaptability and constant transformation. Mist and fog symbolize doubt, the unknown, and indeterminacy (Chevalier & Gheerbrant, 2010, p. 470), representing the complexity and uncertainty of contemporary times, where boundaries become increasingly blurred.

3. Electronic Literature through its Corpus

Before analyzing the exemplary works of each generation and exploring how they integrate and transcend these metaphors, as well as addressing the discussed technological and archaeological challenges, we will present a table that synthesizes and organizes these relationships.

Table 1 | Chronology, Archeology, Symbology (Examples)

Chronology	Archaeology	Symbology	(Examples)
1st Generation (1950 - 1993)	Hardware Preservation	Ice	Pedro Barbosa, *Porto (trovas electrónicas)* and *Aveiro (elegia minimal repetitiva)*, 1977 Silvestre Pestana,
2nd Generation (1995 - present)	Digital Preservation	Liquid Water	*Computer Poetry*, 1981 Antero de Alda, *Oceanografias (a memória da água)*, 1986
3rd Generation (2005 - present)	Network Preservation	Vapor	Rui Torres, *Mar de Sophia*, 2005 André Sier, *MathX (Poemário)*, 2015 d1g1t0 indivíduo_coletivo, *MOIRA*, 2022 Álvaro Seiça & Sindre Sørensen, *aimisola.net/hymiwo.po: a poemtrack for a yet-to-be-written dance piece*, 2015 Liliana Vasques, *robot.sorridente*, 2020 Luís Lucas Pereira, *humaninarium*, 2024

3.1 First Generation: Hardware Preservation (the solidity of the past)

As previously mentioned and explained in various studies (Torres, 2011; Torres & Marques, 2020; Torres & Ministro, 2021), Pedro Barbosa's work with e-literature, both theoretically and creatively, is pioneering and spans all the technological transformations it has undergone. In 1976, at the LACA - Laboratory of Automatic Calculation at the University of Porto, he collaborated with engineer Azevedo Machado using first-generation languages COBOL and Fortran. These languages can be considered classic examples from the pre-Web experimentation era (1950 - 1993), both being widely used in mainframes and large computers of the time.

Among the many other works by Pedro Barbosa that could be mentioned here, *Porto (electronic ballads)* and *Aveiro (repetitive minimal elegy)* are particularly significant as they reflect a set of transitions that reveal how e-literature is intersected by chronological, archaeological, and symbolic dimensions. From these works, the punched tapes containing the data of the poems have survived, as well as the *Permuta* and *Texal* programs, along with printed sheets with textual variations, both on paper and in book form (Barbosa, 1977). These first-generation works are suited for physical preservation as both the NCR Elliott 4100, where they were initially programmed, and the mentioned materials, are still available.

However, it is important to note that these works have also adapted to various other forms of preservation through retextualization processes. Representative of this are the multiple versions created over time:

1) In 1996, a version was produced in MS-DOS and distributed on floppy disk, using Sintext by Barbosa and Abílio Cavalheiro (Barbosa, 1996b), programmed in C++.

2) In 2001, a Java version for CD-ROM and web was developed, using Sintext-W by José Manuel Torres (Barbosa, 2001).

3) In 2014, a version of these poems was created in JavaScript, using poemario.js by Rui Torres and Nuno Ferreira, which was later improved and published in 2016 in the third volume of the Electronic Literature Collection (Barbosa, 2016).

The combinatorial variations of the terms present in Porto ("A SAUDADE DA PEDRA NO GRANITO DA HISTÓRIA [THE LONGING FOR STONE IN THE GRANITE OF HISTORY]") and in Aveiro ("Uma água sem ria na tristeza da alegria [A Water Without a Ria in the Sadness of Joy]") seem to reflect the inherent instability of the permutational text itself, characterized by the constant mutation of meanings.

In Porto, the stone and granite confront saudade and history, while in Aveiro, water and ria are placed in dialogue with sadness and joy. These elements, which define the experience of life in these cities, can be interpreted as representations of the demand for physical preservation (stone/granite as ice), while also carrying a dynamic potential that allows for reinterpretation in new technological contexts (water/ria as liquid).

[9] For a more in-depth analysis of these works by Silvestre Pestana, see Seiça (2015b) and Seiça (2017b).

In addition to the use of mainframes, as exemplified by Pedro Barbosa's work, it is also relevant to highlight works created with the Spectrum range, which is a representative example of 1980s home computers. Although the ZX Spectrum falls within the chronological range of the first generation of e-literature (1950 - 1993), it represents a significantly different technology in terms of accessibility and usage context compared to mainframes and languages such as COBOL and Fortran.

Silvestre Pestana, an artist associated with Portuguese experimental poetry and interactive art, explores expanded poetic forms. Pestana was the first author in Portugal to publish, starting in 1981, a series of three poems programmed in BASIC language, titled *Computer Poetry*. The author dedicates the three program-poems in the series to E. M. de Melo e Castro, Henri Chopin, and Julian Beck, who work in very different fields:

Melo e Castro with videopoetry and visual poetry, Chopin with sound poetry, and Beck with theater. Pestana's poems reflect certain characteristics of concrete and visual poetry, such as the spatialization and constellational organization of signifiers, now expanded into a dynamic medium, bridging to the computer-animated poetry that followed.

Pestana elucidates that the audience for works created with the "new techno-visual writing machines" (1985, p. 203) "is no longer the traditional audience of literary and bookish culture but rather the audio-techno-visual crowds" (p. 205). Moreover, Pestana's non-linear and expansive works demand a new analytical terminology, as he noted: "The dynamic nature of techno-industrial societies compels us to reassess concepts, practices, preferences, and to rethink cause-and-effect relationships" (p. 204).

Like Barbosa's work, Pestana's creations circulate in various forms:

1) The code for two of the poems/programs, dedicated to Julian Beck and Henri Chopin, was published in a box titled "A poética dos anos 80" (Pestana, 1987) in the Domingo! magazine of the *Correio do Porto* newspaper.

2) The code for the three poems was published in the volume *Poemografias* (Pestana, 1985), accompanied by screen captures, and later in the catalog of the Tecnoforma exhibition (Pestana, 2016).

3) Video recordings of the work, which the author made available on his personal webpage and shared in the ELMCIP knowledge base, should also be considered. The videos, which include BASIC code in the early frames, are part of the Fundação de Serralves — Museu de Arte Contemporânea collection in Porto, donated by the artist in 2022, and are featured in various traveling exhibitions.

Pestana's poems explore, in a minimalist fashion, variations based on the word/concept OVO, which is recurrent in his work. From this concept arise the words P_OVO and N_OVO. All of them are dynamically designed and redistributed on the screen. Each new configuration of these words traces a unique path, reflecting the ongoing evolution and transformation of the identity

of a people and of e-literature. Just as ocean waves constantly sculpt and redefine the coastline, the poem/program also shapes and transforms the identity of the Portuguese people, illustrating the fluidity and continuity of its evolution.

A third example of a first-generation work is *Oceanografias (a memória da água)* by Antero de Alda, which is based on linear numerical correspondences between semantically and phonetically similar signifiers (Alda, 2015). Words were assigned numbers from 1 to 24 and randomly combined to create new poems, constrained by specific variables.

As with the other first-generation works mentioned, this one was also presented through various versions and adaptations, each offering a new interpretation of the original ideas:

1) Initially titled *Conjeturas da Água* in 1986, it was developed in BASIC for the Sinclair ZX Spectrum microcomputer. At that stage, the code and examples of generated poems remained unpublished.

2) In 2015, Alda published the code with examples in the book *Oceanografias (a memória da água).*

3) In 2016, the work was retextualized in JavaScript, using the poemario.js by Torres and Ferreira, revitalizing it for the digital age. This version, available in the PO.EX Digital Archive (Torres, 2016), reflects a transition between generations of e-literature.

The updating of the code from COBOL or BASIC to JavaScript or other modern languages can significantly alter the original spirit of the works. This process illustrates the importance of hardware preservation strategies to ensure faithful access to the original material. At the same time, it highlights how combining different preservation strategies can help maintain the continuity of e-literature works, offering a model for future digital conservation practices. However, it also underscores the difficulty of adopting a single approach to preservation.

3.2 Second Generation: Digital Preservation (the fluidity of technologies)

A work from the second generation, now obsolete and unavailable, is *Mar de Sophia*, a textual and sonic engine developed by Rui Torres in Flash and Actionscript, XML, PHP, and Python, with contributions from Nuno Ferreira and Filipe Valpereiro in programming, Sérgio Bairon and Luís Aly in sound textures, and Nuno M Cardoso in voice. The texts were written and programmed based on poems by Sophia de Mello Breyner Andresen and the lexicon of Lewis Carroll.

Mar de Sophia challenges traditional linearity by providing a non-hierarchical reading experience. The poem's structure echoes the rhizome concepts proposed by Deleuze and Guattari (2016). The rhizome, as a philosophical metaphor, is characterized by its non-linear, interconnected, and expansive nature, making a fixed interpretation impossible and promoting an approach with multiple entry and exit points. Just like a rhizome, this work, as with e-literature in general, does not follow a predefined order, allowing readers to choose their reading paths, continuously exploring and creating meanings.

The work served as an interface for possible didactic approaches to e-literature, being utilized by researcher and lecturer Sandra Guerreiro Dias in a pedagogical proposal for introductory linguistic and literary studies (Portuguese I and II). Guerreiro Dias (2020) promotes a performative research attitude that fully incorporates the literary object into student training, aligning with a pedagogy that values interaction and participation.

For the author, this work, "herança do experimentalismo *verbivocovisual* e da literatura programada pós-moderna [a legacy of verbivocovisual experimentalism and post-modern programmed literature]" (Guerreiro Dias, 2020, p. 113), stimulates co-creation and experimentation, challenging readers to participate in the construction of poems through interactions that reflect the complexity and multiplicity of the text.

Mar de Sophia facilitates educational activities including free exploration of the text, guided analysis of its interactive operations, and reflection on the linguistic principles involved (Guerreiro Dias, 2020). These approaches are fundamental to fostering a critical and metacognitive attitude towards language and literature, developing critical thinking skills, and the ability to interpret and create meanings—essential skills in the digital age.

The hypermedia poem is accompanied by intense sound design and incorporates various multimedia elements, constituting a tribute to Sophia's literary universe. The poems were generated from a statistical study of the lexicon of 450 poems by the author available online. After lexical and syntactic filtering, a list of words was created based on the frequency of use in the author's original discourse. This list allowed the textual engine to create virtual combinatory poems. Various combinations of words, sounds, and movements can be experimented with, adjusting the speed at which words and their respective sounds appear on the screen or selecting word lists (Bonacho, 2013).

The theme of water is evident in the title itself and refers to the liquid dimension pointed out by Bauman (2000). Regarding this work and its relationship with liquidity and the rhizome, researcher Vinicius Carvalho Pereira writes: "elementos semióticos presentes nos textos da poetisa portuguesa são relidos em uma estética da deriva e da liquidez no software-poema (...), o qual põe em deslize na tela os sintagmas de Andresen – flutuação do signo poético algo análoga à da navegação no cyberespaço [Semiotic elements present in the texts of the Portuguese poetess are re-read in an aesthetics of drift and liquidity in the software-poem (...), which places Andresen's phrases in slide on the screen—similar to the poetic sign's fluctuation to navigation in cyberspace]" (Pereira, 2017, p. 13).

MathX (Poemário), by André Sier in collaboration with Rui Torres, is also a second-generation work that combines texts and algorithms to create an interactive and three-dimensional poetic experience. Through a digital environment programmed by Sier, which presents itself as a vast sea open for exploration by readers, they are invited to interact with a varied and fragmented collection of poems, charting paths, capturing images of the environments, and restarting the navigation experience.

The work uses digital processing and voice synthesis to explore new possibilities for poetic expression. Interaction is achieved through keyboard commands, requiring the installation of specific libraries and voice synthesizers for full functionality.

Including poems by Pedro Barbosa and E. M. de Melo e Castro, it constitutes a revisitation and reinterpretation of historical texts from Portuguese experimental and digital poetry, circulating them in renewed forms and through different audiences. Situated within the chronological context of second-generation works, its code is available, allowing for recreation through digital preservation. However, the work also connects with third-generation works, as it is a playable object that can be exhibited in physical spaces, shared, and acted upon collaboratively.

Finally, *MOIRA*, by dıgıto individual_collective, is a second-generation work that invites the reader to explore the universe of the Enchanted Moiras. The interface simulates the waters of a digital well, where a web of words is found. The work presents the voice of a Moira as a liquid whisper, recombined with words that intertwine, aligning with the theme of water in its liquid state, associated with second-generation e-literature works. Developed in JavaScript with HTML and CSS, languages that enable web interactions, MOIRA requires the participation of its readers, transforming them into co-creators, as their choices directly influence the unfolding of the narrative and the potential liberation of the Moira.

Inspired by the Moiras, figures of destiny in Greek mythology, the work links the mythological past with the digital present through the retelling and reinvention of these stories, creating a timeless narrative that serves as an educational tool concerning intangible heritage and digital preservation. This fusion of mythology and technology exemplifies the dialogues between art and technology that define e-literature.

Described by its creators as a project of "investigAÇÃO artística [artistic investigACTION]" (Marques & Gago, 2023, p. 37) and "participatory art," MOIRA has a significant community and artivist concern, recognizing the goal of "promover o envolvimento da comunidade, enquanto agente fundamental para o questionamento e (re)criação artística do (seu) património [promoting community involvement as a fundamental agent for questioning and (re)creating artistic (its) heritage]" (Marques & Gago, 2023, p. 44).

The authors clearly highlight the educational dimension of e-literature: "se pensarmos nas aplicações didáticas que [a e-literatura] proporciona, a partir da literacia processual, para a literacia linguística e, por fim, para a literacia artística, a utilização de meios tecnológicos digitais acaba por contribuir para aumentar níveis de literacia digital (...) [if we think about the didactic applications that [e-literature] provides, from processual literacy to linguistic literacy, and finally to artistic literacy, the use of digital technological means ends up contributing to increasing levels of digital literacy]" (Marques & Gago, 2023, p. 55). Although in different forms, all three second-generation works require digital preservation strategies to ensure their long-term readability. Despite being currently unavailable, *Mar de Sophia* remains subject to digital preservation, as, like the others, its code has been shared with the community and extensively described and commented on by its authors.

3.3 Third Generation: Network Preservation (the volatility of the digital age)

The collaborative project *HYMIWO.PO (HYmn to imMIgrant WOmen, a Poem)*, created by Álvaro Seiça and Sindre Sørensen, explores the conditions faced by African immigrant women in Spain from their perspective (Seiça, 2017a). Within this project, Seiça and Sørensen developed an interactive and playable poetic structure to offer an immersive and reflective experience on immigration: *aimisola.net/hymiwo.po: a poemtrack for a yet-to-be-written dance piece.*

The work *aimisola.net/hymiwo.po* is not just a digital poem. Through the creation of a wiki, the authors established a digital archive with audio, video, and images, documenting interviews with immigrant women, language learning workshops, professional training, and social meetings organized by a Spanish NGO (Seiça, 2017a). In line with other third-generation works, a notable feature of *aimisola.net/hymiwo.po* is its playability.

However, unlike conventional games where speed is crucial for "leveling up," *aimisola.net/hymiwo.po* adopts a contemplative approach. For this purpose, the word "silence" acts as a sort of player avatar (Berens et al., 2022), moving slowly from left to right across the screen. It encourages the reader to interact with the words and emoticons that appear and disappear on the screen, which are aggregated from Twitter hashtags (Seiça, 2017a).

aimisola.net/hymiwo.po demonstrates how digital poetry can be used as a tool for artistic expression, linguistic experimentation, and social awareness. The interactive and multimodal approach of this poem-game also contributes to digital literacy strategies, encouraging a deeper understanding of the relationship between technology and culture, and between code and art. By engaging readers in a creative and critical exploration of media, such as real-time use of Twitter, the project suggests a navigation and interpretation of the digital world that is more effective.

A second work within the chronological scope of the third generation is *robot sorridente* by Liliana Vasques. This piece challenges our expectations of what poetry can be on a platform like Instagram. Using this social media platform, Vasques presents her robot as a nearly conscious entity that creates space for various poetic formats and strategies in the digital realm, including visual and concrete forms, animations, and short videos. By appropriating the typical web interface layout of Instagram (three images per row, creating a kind of dynamic mosaic of poems), the work, when viewed as a whole, provides a visual rearrangement of the images, giving them a strangeness that can be meaningful in educational contexts.

robot sorridente does not yield to the easy comprehension that sometimes characterizes third-generation e-literature works. Indeed, most approaches are ironic and opaque, and Vasques aesthetically plays with glitches, blurring, and misalignment.

The work also functions as a feminist critique of the trend among Instapoems to simplify narratives (Berens et al., 2022c), thus encouraging a deep reflection on feminine identity and experience in the current web environment.

Finally, we highlight the creative work of programmer Luís Lucas Pereira, particularly how he uses the social platform Instagram through the profile *@humaginarium* to complementarily showcase his multiple programmed poems. Recalling our previous note on the limitations of using images

and videos to capture a digital work, and recognizing that these techniques only partially address the complexity of generative works, Pereira's use of Instagram prompts reflections that can be applied in educational contexts addressing the chronological, archaeological, and symbolic issues we've discussed.

Indeed, Instagram is not used by the author merely as a publishing medium, since all the works featured on his profile page have their own independent and autonomous space. Instead, the platform is used as a space for the reconstruction and repositioning of partial elements of the works themselves.

The neologism *humaginarium*, combining the words "human" and "imaginary," suggests a space or entity where human imagination is explored, preserved, and possibly expanded. This concept is directly related to the themes we've been discussing, as in e-literature, technology serves as a means for new forms of artistic and literary expression. The idea of *humaginarium* resonates with various previously discussed works, which allow poetic imagination to be continuously explored and reinvented through new technologies.

Based on the examples presented, extracted from a broader and still developing corpus, we can conclude that e-literature provides a dynamic space where human imagination can be continually reconfigured. The "humaginarium" can also be seen as a digital environment where poetic navigation experiences are organized and preserved, allowing us to address, explore, and confront contemporary social issues. Thus, the neologism "humaginarium" encapsulates the essence of the projects and works discussed, offering a powerful metaphor for the digital space and its relationship with e-literature.

Finally, it is important to note that third-generation works present significant complexity in terms of future preservation. Network preservation involves the need to encapsulate and maintain social networks and collaborative platforms, which are often not open or provide available code. This represents a substantial challenge, as these platforms are volatile and constantly evolving, requiring adaptive preservation strategies to ensure the longevity and accessibility of the works.

4. Reflections on Digital Literacy

The socio-cultural profile of digital natives (Gen-Z, born between 1997-2010, and Gen Alpha, born after 2010) is significantly linked to the third generation of e-literature. This generation, as proposed by Flores (2021), should be understood through the lens of participatory cultures. According to Henry Jenkins (Jenkins et al., 2009), a participatory culture fosters artistic expression and civic engagement. In a participatory culture, individuals believe that what they do is meaningful, leading them to feel a certain degree of social connection and closeness with others.

Participatory cultures, like many of the e-literature works mentioned, point to the need for policies and pedagogical interventions (Jenkins et al., 2009). Various multinational models outline the values, attitudes, skills, and knowledge necessary for an active and responsible citizen to fully exercise their citizenship in a networked society. Among these models, the one from

the European Commission (Council of Europe, 2019) stands out, with a particular emphasis on digital competence, highlighting the importance of developing citizens' digital literacy (Vuorikari et al., 2022). Other models include "global competence" (OECD, 2018) and "education for global citizenship" (UNESCO, 2015). Additionally, the Council of Europe model defines a digital citizen as someone who demonstrates competence and positivity when dealing with the constant evolution of digital technologies, participating actively, continuously, and responsibly in civic and social activities, and committing to the ongoing defense of human rights and dignity (Council of Europe, 2019).

E-literature contributes to the development of essential skills such as digital literacy, critical thinking, and creativity. It offers a playful dimension, creating experiences that encourage exploration, improvisation, and discovery.

Moreover, it stimulates digital natives to interpret and build dynamic models to understand the real world. E-literature requires navigation, analysis, evaluation, and orientation within the texts; without these skills, navigation can become aimless due to a lack of a clear understanding of the path. Attention and critical thinking are crucial in digital literacy, as digital texts are often democratic, promoting open participation and contribution in virtual environments, with an almost total absence of authority in sources. Besides the challenge of dealing with the lack of authority in a frequently tumultuous and noisy digital space, the issue of choosing and selecting the reading path arises, which translates into a semiotic sequence of selective movements. An ergodic text, as defined by Aarseth (1997), demands significant effort to be read and interpreted.

The teaching of e-literature can significantly contribute to developing a range of essential skills. According to Artur Matuck, electro-writing offers the possibility of reconfiguring texts as potential material, serving as "matrizes para reedição, recombinação e processos de análise, investigação, transformação, tradução e reprocessamento [matrices for re-editing, recombination, and processes of analysis, investigation, transformation, translation, and reprocessing]" (Matuck, 2011, p. 63). Additionally, within the realm of e-literary objects, the reader transcends the role of a passive and solitary recipient, adopting an active and collaborative stance in the creation and realization of the literary project. This reader acts as an active, creative, and manipulative participant, capable of filling gaps, finding answers, and defining paths in open, available, and flexible proposals.

The Digital Literacy Action Plan (2021-2027), developed by the European Commission, identified digital literacy as an essential competence for the 21st century. The priority is to promote the development of an effective digital education ecosystem. The second priority focuses on strengthening the digital skills and competencies necessary for digital transformation, recognizing the importance of working with more creative, interactive, and available digital educational content in various formats. Using the approaches and methods discussed—such as the relationships between chronology, archaeology, and symbolism—we can adopt a series of strategies to highlight the educational potential of e-literature.

At a chronological level, e-literature enables reflection on generational differences, promoting an understanding of history and technological evolution, as well as changes in ideas and human

practices associated with these transformations. The dematerialization of e-texts requires a robust technical apparatus, which not only reflects but also reveals the evolution of communication forms, supported by ever-changing technological media and signs. Digital writing, as a communicative technique driven by technological advancement, is characterized by continuous mobility that dematerializes and challenges its original meaning, resulting, as described by Maria Augusta Babo, in a "desterritorialização que a transforma num puro objeto nômade [deterritorialization that transforms it into a pure nomadic object]" (Babo, 1996).

At an archaeological level, e-literature promotes an aesthetic of care and curation, adopting methods of attentive reading. The breakdown of material text boundaries in the virtual environment encourages the reader to actively participate in a process akin to writing, where reception is integrated with production due to the performativity inherent in discourse. In a context where the text loses its unique corporeality, e-textuality facilitates the understanding of this dematerialization, allowing discourse to transition between different languages and multimedia devices. Reading, as a process of meaning construction, also assumes the responsibility of fixing the text, image, sound, or other signifiers. The technique used in e-literature acts as a mediator of reality, functioning as a mechanism of knowledge about the world. It offers not only the possibility to enrich awareness of the current world but also to understand the context, memory, and history of the past. This memory is updated by human digital competence, while the record of past events, or inorganic memory, allows the eternalization of human experience beyond physical death through its inscription in archives or external technological memory devices (Babo, 2004).

At a symbolic level, e-literature aligns with various themes and objectives of the UNESCO Sustainable Development Goals (SDGs), such as promoting well-being, quality education, gender equality, reducing inequalities, responsible consumption, climate action, peace, and social justice. The 21st century is characterized by unprecedented digitalization of communication. Although the benefits of digital media are undeniable, their indiscriminate and uncritical use has generated misinformation, hatred, and intolerance, threatening the sustainability of tolerant, inclusive, and democratic societies. E-literature can act as an ally in digital literacy, helping to develop essential digital competencies and skills to ensure that everyone has equal opportunities to thrive and engage as active citizens. Additionally, it promotes a critical process that fosters a culture of open and inclusive communication, grounded in respect for human rights and democracy, significantly contributing to human development.

CONCLUSIONS

The proposed triangular approach, which integrates chronological, archaeological, and symbolic perspectives, provides an effective framework for understanding the different generations of e-literature in Portugal. The chronological perspective, as identified by Flores (2021), outlines three distinct generations of e-literature, ranging from early experiences before the World Wide Web to contemporary uses of social networks and mobile applications. The archaeological perspective, based on Montfort and Wardrip-Fruin (2004), focuses on the challenges and strategies of digital preservation, aiming to ensure the accessibility and readability of works over time. Finally, the symbolic analysis, supported by Chevalier and Gheerbrant (2010), uses the metaphor of water to

illustrate the continuous transformations and flows in e-literature practices.
By integrating these three perspectives into the analysis, we can demonstrate how the works not only incorporate the proposed metaphors but also address the technological and archaeological challenges discussed. This theoretical foundation contributes not only to the preservation and understanding of e-literature but also ensures that these works remain accessible and relevant for future generations. Thus, e-literature stands out as a dynamic and essential field for digital literacy, playing a crucial role in promoting inclusive and critical communication in the digital age.

The selected works illustrate the media, cultural, and technological diversity of e-literature, highlighting its value both as a pedagogical tool and as a means of promoting digital literacy. Its capacity for continuous reconfiguration and adaptation emphasizes e-literature's potential to enrich the literary and educational experience.

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