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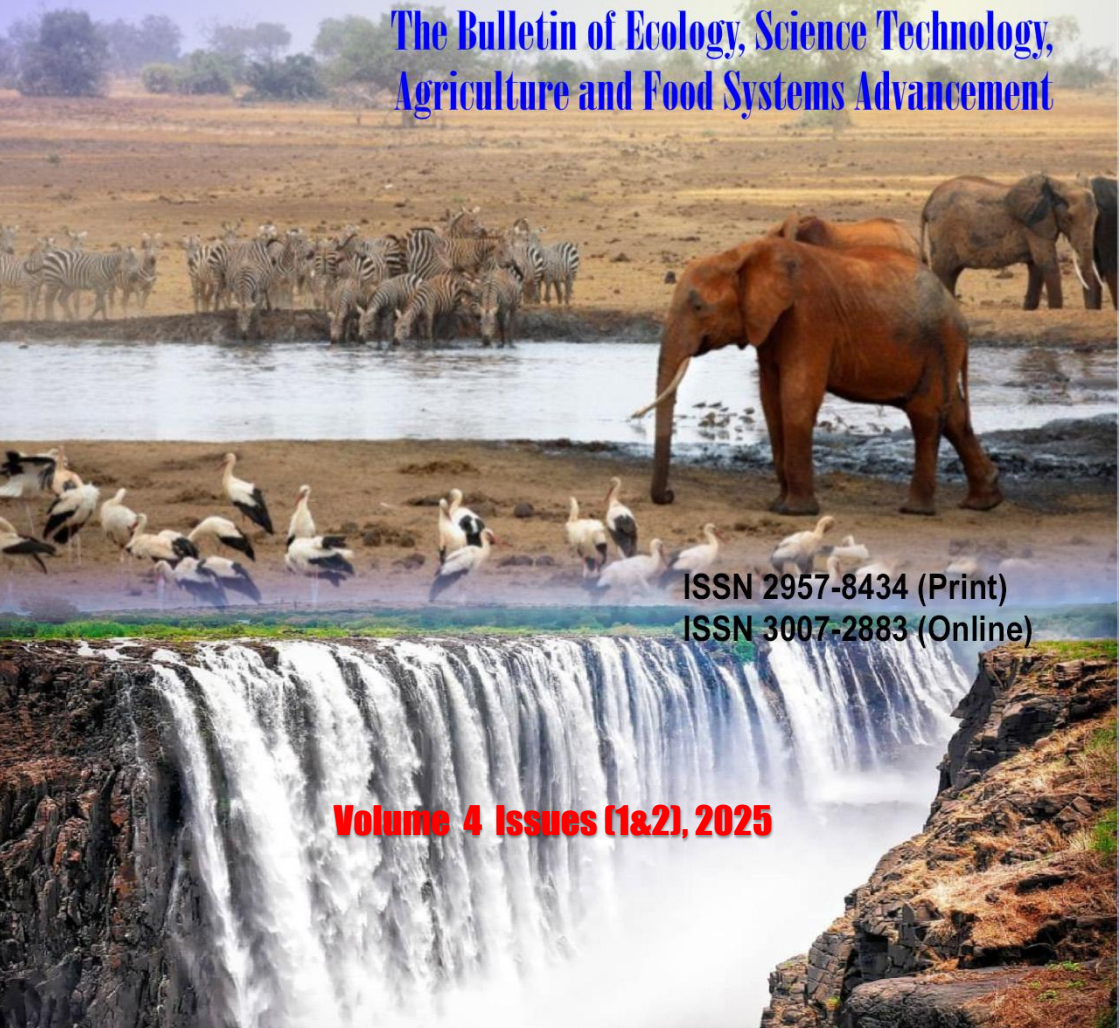
The Zimbabwe Ezekiel Guti University
The Bulletin of Ecology, Science Technology, Agriculture and Food Systems Advancement



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The purpose of *the Oikos - The Zimbabwe Ezekiel Guti University Bulletin of Ecology, Science Technology, Agriculture and Food Systems Review and Advancement* is to provide a forum for scientific and technological solutions based on a systems approach and thinking as the bedrock of intervention.

CONTRIBUTION AND READERSHIP

Natural scientists, engineering experts, technologists, multidisciplinary teams are encouraged.

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DESIGNING A CULTURALLY RESPONSIVE E-LEARNING USER INTERFACE FOR ZIMBABWEAN PRIMARY SCHOOLS: A SEMIOTIC AND ACTION RESEARCH APPROACH

DAGLOUS MASVETA[1] AND BATSIRAI CHIVHANGA[2]

ABSTRACT

This study addresses the challenges of poor User Interface/User Experience (UI/UX) design in e-learning platforms for primary school learners in Zimbabwe, which often lack intuitive usability and cultural relevance. To tackle this issue, the research adopts a culturally responsive design approach, guided by Peirce's Semiotic Theory (sign, object, interpretant) and the Action Research Methodology. By integrating culturally meaningful symbols, metaphors and signs, the proposed platform, Educulture, aims to enhance user engagement and minimise cognitive load. Through iterative testing with teachers and learners, key interface elements like typography, colour schemes and gamification features are refined. The findings highlight that combining semiotic principles with participatory design significantly improves the accessibility and effectiveness of e-learning in multicultural settings. This study provides

[1] Chinhoyi University of Technology, School of Creative Art and Design, Zimbabwe https://orcid.org/0009-0009-2132-581X , daglousmasveta@gmail.com

[2] Chinhoyi University of Technology, Department of Creative Art and Design, Zimbabwe, https://orcid.org/ 0009-0003-3727-507, batsichivhanga@gmail.com

practical recommendations for creating inclusive and culturally sensitive educational technologies.

Keywords: E-learning design, User Interface, User Experience, Inclusive Education, E-learning platforms, Primary School Learners Peirce's Semiotic Theory, Gamification

Introduction

The rapid advancement of digital technology has significantly transformed the educational landscape, leading to the widespread adoption of e-learning platforms as a primary mode of instruction (Dhawan, 2020). E-learning platforms offer flexible, accessible and personalised learning experiences, making education more inclusive and adaptable to diverse learner needs (Singh and Thurman, 2019). This aligns with the mission statement of the Zimbabwe Ministry and Primary Education (MoPSE) which emphasises the provision of equitable, quality, inclusive, relevant and competence driven primary, secondary and non-formal education. The Heritage Based Curriculum 2030 (HBC 2024-2030) also concretises the mission statement through advocating for the increase in inclusivity and disaster resilience, new school construction, as well as renovation and expansion of current school infrastructure, including classrooms, specialist rooms and internet access. This aligns with the United Nations Sustainable Goal 17 (SDG 17) which notes that partnerships and collaborations should play a central role in developing and implementing effective, localised LMS solutions. Despite their growing popularity, many e-learning systems struggle with user engagement, retention and satisfaction due to poor User Interface (UI) and User Experience (UX) design (Alvarez *et al*., 2021). The designers opine that the implementation of policy directives lies with the MoPSE, hence there is no policy articulation from the ministry clearly spelling out the guidelines in which primary schools could implement e-learning in all the schools. A well-designed UI/UX is essential in ensuring that learners can navigate the platform efficiently, remain motivated and successfully achieve their learning objectives (Norman, 2013).

Educulture, a hypothetical e-learning platform in this study, aims to integrate cultural education with modern pedagogical approaches. Like

many e-learning systems, it may encounter usability issues that hinder learner engagement. Cross Cultural Design (CCD) is essential since it aims at the deployment of system interfaces to be in harmony with users' cultural habits, language use and the learning context (Ford and Kotzé, 2005). Localisation in the Zimbabwean setting could involve inclusion of local languages such as Shona and Ndebele alongside English to expand coverage. Culturally descriptive icons, metaphors and imagery can also render interfaces more intuitive and familiar (Evers and Day, 1997). Researches demonstrate that poorly designed e-learning interfaces contribute to cognitive overload, frustration and high dropout rates (Sweller *et al*., 2019). Pedagogical models that are specific to the local setting, i.e., *ubuntu*-based collaborative learning, can similarly be accommodated in LMS design in order to facilitate congruence with Zimbabwean communal cultural heritage (Mawere, 2024).

To address these challenges, an iterative design approach such as Action Research (AR) can be used to continuously refine the UI/UX based on direct user feedback (Stringer, 2014). Action Research is particularly valuable in educational technology as it bridges the gap between theoretical design principles and practical user needs, ensuring that the platform evolves in response to real-world usage patterns. This culminates to indigenous knowledge systems (IKS) which emphasise community-based knowledge sharing, oral traditions and practical problem-solving, which can be digitised and embedded into LMS platforms (Hoppers, 2002). For instance, local content and multimodal presentation were employed in the MobiLiteracy Uganda programme to support adult literacy (Wagner *et al*., 2019). Similarly, localised academic content offline was disseminated through the eGranary Digital Library in Kenya, bypassing infrastructure challenges (Fuchs and Horak, 2008). The present researcher uses these examples to shed light on and highlight the capabilities of locally adapted e-learning platforms to propel education in Zimbabwe through integrating technological progress with local cultural conditions.

The synergy between UX and UI design has emerged as a pivotal factor in the efficacy and success of e-learning platforms. The importance of

UI/UX in e-learning cannot be overstated. Berni and Borgianni (2021) note that despite numerous endeavours to converge on a unified definition of UX through initiatives such as workshops like "Towards a UX Manifesto" (Law *et al*., 2008), scholarly seminars (Roto *et al*., 2010) and comprehensive surveys (Law *et al*., 2009), the conceptualisation of UX remains ambiguous. In this scenario, the ambiguity is attributed to the plethora of interpretations and nuanced acceptations, notwithstanding the underlying commonalities. UX design is fundamentally concerned with the holistic feel of a product, encompassing the myriad ways users engage and interact with any digital environment (Kim and Cho 2016; Nurpalah *et al* 2021). UI refers to the visual and interactive elements of a platform like layout, buttons and navigation menus, while UX encompasses the overall experience which includes ease of use, accessibility and emotional response (Garrett, 2011). In e-learning, an effective UI/UX design enhances learner engagement by minimising distractions and improving content comprehension (Mayer, 2017). Studies indicate that learners are more likely to complete courses on platforms with intuitive designs and responsive feedback mechanisms (Kumar and Sharma, 2020). Despite these benefits, many e-learning platforms prioritise functionality over usability, resulting in complex interfaces that discourage rather than facilitate learning (Nielsen, 2012).

The research is of the view that user-centred design principles should be incorporated in the design process of any e-learning platform so as to ensure that cultural and educational content is presented in an accessible and engaging manner. Therefore, UX and UI can be compared to an iceberg, where UI is the visible part above water and UX representing the significant but hidden portion below the surface (MacKenzie, 2014). The study opines that an in-depth comprehension of the target users, encompassing their psychological profiles, societal constructs, cultural values, age demographics and cognitive capabilities fundamentally informs and shapes the UI of any e-learning platform. Users are willing to see the system interface in accordance with their needs and requirements (Vlasenk *et al* 2021). This multifaceted discipline integrates comprehensive user research, behavioural analysis and iterative design methodologies to curate an experience that is not

only functional, but also enjoyable and accessible. One can point out that, successful UX design hinges on understanding user needs and motivations fostering an intuitive interaction that enhances learning outcomes. According to Sun and Teng (2017), cited in Berni and Borgianni (2021), the conceptualisation of UX resides within the domain of affective responses and emotional engagement which are intrinsically linked to the notion of joy of ownership. Ji *et al* (2018), Cahyad and Pratama (2020) and Iswari (2021) aver that UI is a link that connects human and computer interaction, where users will interact with computers to complete tasks. UI design zeroes in on the aesthetic and interactive elements of a product. Meixne *et al* (2011), in Pratama and Cahyad (2020), extrapolate that the user interacts with the interface physically, perceptually and conceptually. Therefore, the interactive elements are crucial in crafting an engaging and aesthetically pleasing interface that guides user behaviour and enhances usability (Nurpalah *et al* 2021). UX is how users use the application (Pratama and Cahyad 2020).

UX encapsulates the entirety of users' affective states, cognitive beliefs, individual preferences, perceptual interpretations, physiological and psychological reactions, behavioural tendencies and accomplishments, which manifest throughout the pre-use, active use and post-use phases, as posited by Rusu *et al*. (2015), in Pratama and Cahyad (2020). The interplay between UX and UI design is particularly salient in the context of digital e-learning platforms, where effective design can significantly influence educational engagement and retention. Thus, the good nature of UX is that it is contextual and subjective (Mirnig *et al* 2015), hence it is complex (Vlasenk *et al* 2021). UI and UX encompasse three approaches which can be individuated as design thinking (DT) (Henriksen *et al* 2017; Chou 2018; Nakata and Hwang 2020, user-centred design (UCD) (Shivers-McNair *et al* 2018; Zorzetti *et al* 2022) and human-centred design (HCD) (Gaspar *et al*, 2019; Flood *et al*, 2021). This, therefore, explains that essential skills for UX designers encompass user research and analysis, wire framing, prototyping, usability testing and a solid grasp of information architecture. It is clear that UI and UX are two of the quintessential mechanisms that play a crucial role in development of a user-friendly and high-quality product (Ilpate, 2023). The user,

system and context of use are considered a collective phenomenon in designing, engaging UI backed by UX which involves user's individual experiences. UI designers deal with visual design principles which are the tenets of creating visually compelling and user-friendly interfaces. Stoeva (2021) also extrapolates that UI application requires the implementation of display and interaction intelligence requires front-end designers who understand the design of a UI/UX design. Common skills that bridge both disciplines are creative problem-solving, collaboration and effective communication. The integration of these skills enhances the learner's journey and fosters a more immersive and effective educational experience.

Norman (2013) extrapolates that understanding human behaviour is crucial in design technology and designs should be designed the way people want, not the way designers want. This was after Tracy Leonard (1996) wrote:
"Don't do to others what others have done to you. Remember the things you don't like in software interfaces you use. Then make sure you don't do the same things to users of interfaces you design and develop."

Therefore, these researchers opted for Action Research since it provides a robust methodology for refining UI/UX design through continuous iteration. Developed by Kurt Lewin (1946), AR is a participatory research method that involves identifying problems, implementing solutions and evaluating outcomes in real-world settings. In the context of UI/UX design, AR allows designers to collaborate closely with end-user's learners and facilitators to refine the platform based on ongoing feedback (McNiff, 2017). This empathetic approach is essential in UX/UI design as it allows designers to put themselves in the user's shoes and create UIs that meet user's needs and expectations. UX informs UI, hence designers should draw from their own experiences as users to inform their design decisions. Personalised learning experiences, facilitated by adaptive learning technologies and responsive feedback systems cater to individual learners' needs and learning styles, thereby enhancing their overall learning experience (Stowers, 2022). Accessibility features like screen reader compatibility and adjustable text sizes, ensure that educational tools are usable by all

students, including those with disabilities and, therefore, promoting inclusivity and equal learning opportunities. By prioritising these aspects of UX design, educational platforms can create a more supportive and effective learning environment, ultimately leading to improved learning outcomes (*ibid*.).

The success of the Educulture e-learning platform hinges on its UI/UX design. Poor usability can lead to disengagement and high attrition rates, while a well-optimised interface enhances learning efficiency and satisfaction. By employing AR, this study aims to iteratively design the Educulture e-learning platform, ensuring that it meets the needs of diverse learners. The findings will contribute to broader discussions on effective e-learning design, offering practical insights for educators, instructional designers and developers. The study also highlights the value of participatory design methods in creating digital learning environments that are both functional and user-friendly. The study is also filling the gap since most of the studies in Zimbabwe and globally are focusing on implementation of e-learning in higher education, leaving out primary school learners and they are also not prioritising the design of age appropriate platforms which fosters inclusivity within the educational milieu (Obeng and Coleman (2020); Dube and Chisaka, 2021; Maonde and Mutsvara, 2021; Nhongo and Tshotsho, 2021; Ouma (2021); Ssemugenyi and Seje (2021); Jovanka (2023); Maune (2023); Calonge *et al*. (2023); Barikzai *et al*. (2024); Rulinawaty *et al*. (2024); Widowati and Tyas (2024); Kamoyo *et al*., (2025)). To plug this gap, the study designed an engaging e-learning user interface for Grades 4-7 learners called Educulture following Action Research process.

Theoretical Development

Theoretical Review

The Semiotic Theory is the main theory underpinning this study.
The term "semiotics", derived from the Greek word *semeiotikos*, refers to the study of signs and symbols, their use, interpretation and meaning within a specific context (Chandler, 2017). Semiotics encompasses the understanding of signs as well as their representation through voice and

picture (Eco, 1976). Pierce (1998) considers the father of semiotics, categorised signs into icons, indexes and symbols. In interface design, icons rely on visual resemblance, navigation buttons function as indexes of location or control and language-based elements operate symbolically (Galizia, 2019). This model is worth employing in developing effective e-learning UIs for Zimbabwean primary learners with diverse cultural backgrounds and learning patterns. The Semiotic Theory posits that meaning is not an inherent quality of symbols or objects; instead, meaning is created through the relation between the signifier and the signified and is mediated by shared understanding and cultural codes (*ibid.*). In web interface design, all elements such as buttons, icons and color possess meaning and can exert a significant influence on user engagement and understanding (Mirsarraf *et al*., 2018). Designers must prioritise the cultural iconography and conventions indigenous to Zimbabwe, which is a highly symbolic and visually represented country. Through the use of recognisable imagery taken from Zimbabwean folklore or Zimbabwean traditional art forms, designers will be able to increase learner interest and comprehension.

The Piercian Semiotic Triangle, developed by philosopher and logician Peirce (1998), is a useful tool for web designers, particularly in designing the UI of websites for novice learners. The triangle breaks down the elements of a sign into three components: the representamen, the object and the interpretent. Marsarraf *et al*. (2018) hold that the images presented in a web interface are all signs that symbolise or convey meaning to the user.

Figure 1 illustrates the Piercian Semiotic Triangle for web interface design

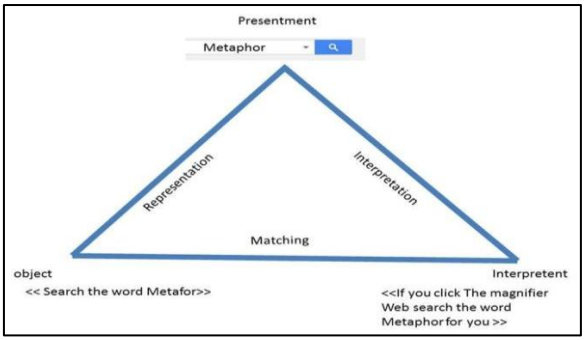

Figure 1: A semiotic model of a user-interface signs to search the web for word Metaphor

Source: Mirsarraf *et al* (2018).

At the middle of the triadic model is the representamen, or the sign itself. In interface design, this can be in the form of icons, buttons or graphics laid out on a webpage. These graphical components are the most common methods of interaction between the user and the interface. This constitutes what is being represented by sign in the real world, such as actions, concepts or emotions. It is necessary that the users know the meaning and how the sign works. The interpretant is the user's interpretation of the sign. It entails the mental representation or cultural meaning that the user attaches to the representamen and the object. The interpretant is highly subjective and may differ based on personal experiences and cultural variation.

Norman (1988), cited in Mirsarraf *et al*. (2018), stresses that one of the critical aims of a UI is to assist users in forming an accurate mental model of the system. Simple and clear language, combined with visual prompts, can significantly improve understanding, especially for individuals with low English language proficiency. As an acknowledgment of student diversity in learning styles, the Semiotic Theory can inform the creation of multimodal interfaces that facilitate a range of learning styles. To illustrate the practical use of the Peircean triad, imagine an elementary school children's website with a game. Here, a big, brightly coloured "play" button could be the representamen,

announcing the beginning of the game. The interpretant is the user's understanding that clicking the button will initiate the game. By maintaining consistency and alignment between the representamen, object and interpretant throughout the website, primary school learners will intuitively grasp how to interact with other elements and navigate the interface. The use of the Piercian semiotic in web interface design is crucial as it provides a straightforward triadic model that helps create signs in ways that the audience understands (Littlejohn, 1999:330; Marsarraf *et al*., 2018).

Methodology

The study is based on the premise that scholars, teachers and learners collaboratively improve their understanding and practices. The study employs Action Research which is a self-reflective inquiry by participants in social situations to enhance the rationality and justice of their practices, understanding and the situations where these practices occur (McNiff, 1988: Saunders *et al* 2019). Action research is conducted with people who benefit from the actions, findings and resulting changes (Wilkinson 1996; Mertler 2021) as exemplified by the learners and teachers from the selected primary Schools (A and B) in Zvimba District, Mashonaland West Province, who participated in this study. The research focuses on Grades 4 to 7 primary learners, teachers and school headmasters from the Nyabira Cluster in Zvimba North District, Mashonaland West Province since they were they convenient for the research. Within this cluster, comprising seven schools, the research purposively chose two schools, referred to as School A and School B. The total target population included 1 224 learners and 44 teachers, resulting in an overall total of 1 268 individuals. The study sample consists of 16 learners, 10 teachers and two heads of each school. Specifically, in School A, eight learners, fiv5 teachers and one headmaster were selected, while School B had the same number of participants. Both schools are equipped with computer laboratories, with School A having one lab that contains 17 functional computers and School B having a lab with 19 functional computers. This similarity in their facilities means that both schools share comparable characteristics. The collaborative involvement of researchers, teachers and learners not only facilitated professional development, but also allowed for the

collection of valuable best practice data to be used in the designing of e-learning UI. This approach helped to interpret participants' views by exploring their needs and perceptions to develop a usable interface. The researche also utilised purposive and convenience sampling methods. Geographical proximity was a key factor in selecting participants, as it was challenging to reach individuals in various parts of the country.

Grundy (1995) and Reason (2006), in Saunders *et al*. (2019), assert that action research aims to promote participation and improvement through improving activities, the environments in which these practices occur and the understanding of both. This aspect was crucial for this study as stakeholder participation provided insights into expected UI usability improvements, facilitating deep exploration of the issues. Guided by Saunders *et al*. (2019), the research adopted Kemmis and McTaggart's (1982) four fundamental aspects of the action research process: planning, acting, observing and reflecting, creating a dynamic, iterative cycle. This strategy proved relevant for the designing of the Educulture e-learning platform as it supported continuous refinement based on practical feedback and collaborative input. Figure 2 shows the Action Research Framework.

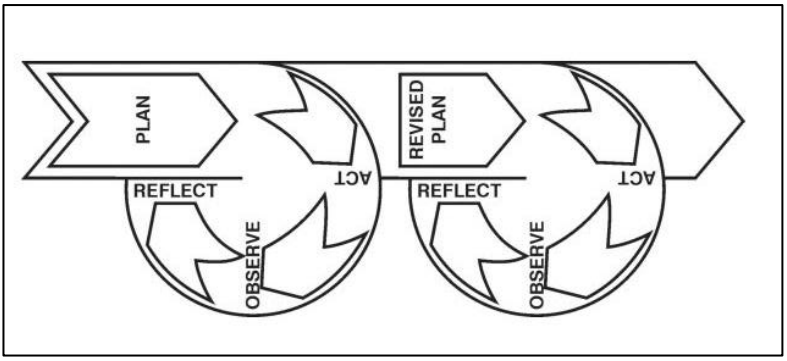

Figure 2: Action Research Framework
Source: Kemmis and McTaggart's (1982)

The design process was broken down into two phases (Phase 1 and Phase 2) following Kemmis and McTaggart's (*ibid.*) major aspects of

planning, acting, observing and reflecting. The aspects were crucial in this design and make project of designing engaging UI for primary learners as it provides essential data and helps in determining the design process.

Phase 1

The planning phase involved identifying learning objectives, needs and challenges. This was the initial action development stage, data were gathered through document analysis, interviews and open-ended questionnaires (Cohen *et al*, 2018). In research, planning is where the research questions and objectives are defined and methods and procedures for collecting and analysing data are selected (Cresswell and Cresswell, 2018). This approach allows for in-depth analysis of learner experiences and meanings when using online websites and their UIs (Kvale and Brinkmann, 2015). In addition to this, existing UIs for e-learning technology capabilities are discussed and observed along with lessons, lab equipment and related e-learning tools (Lichtman, 2010). This phase also directs the development of a preliminary design for a low fidelity paper prototype that was subsequently transformed into a medium fidelity e-learning UI prototype through processes illustrated on paper, driven by the findings from target audiences (Rossman and Rallis, 2017). From this stage the user needs were found and analysed to come up with a UI prototype.

Phase 2

This phase involved putting the design plan into action, monitoring its effectiveness and reflecting on the findings (Kemmis and McTaggart, 2018). This phase is characterised by the cyclical process of design, which is a characteristic of action research (Cresswell, 2020). Phase 2 started with the execution of the design plan, which involved prototyping a new medium fidelity e-learning UI prototype based on the findings of Phase 1 (Bryson, 2020). The new medium fidelity e-learning UI prototype was subsequently tested for usability among teachers and students from schools A and B. This testing provided valuable feedback and identified possible areas of improvement (Krug, 2019). Interviews and observations were also conducted to find out more and penetrate any grey areas (Creswell and Creswell, 2018). This

helped to determine how well the new medium fidelity e-learning UI prototype was and what trends, themes and what had to be improved (Miles *et al*., 2020). Reflection was a critical component of this phase because it allowed the study to set out implications of the findings and provide further findings and recommendations to teachers and learners (Schön, 2017). Reflection also informed action and subsequent refinements of the design process. The following design process was followed:

An initial site map establishing the platform architecture

The site map served as a detailed master plan for the Educulture site, clearly specifying all pages and their hierarchical organisation as well as articulating user flow. This graphical documentation played an important role in the design process by guaranteeing that all the user needs located in the research results were systematically addressed. By applying information architecture principles, the site map organised related content into logical groupings, establishing an intuitive navigation pattern that enhanced user experience and platform discovery. As a strategic summary, the site map enabled designers' capacity to find and fill gaps in content through collaborative review with educators and administrators prior to implementation. The platform's architecture features distinct entry points for its three groups of users (learners, teachers and school administrators), each of which logs in to view role-specific dashboards.

The Educulture site map is shown in Figure 3.

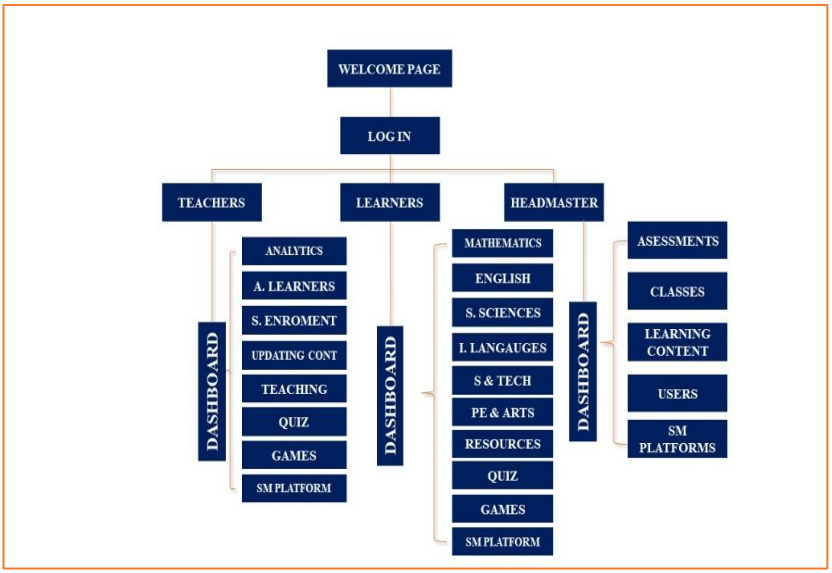

Figure 3: Educulture site map

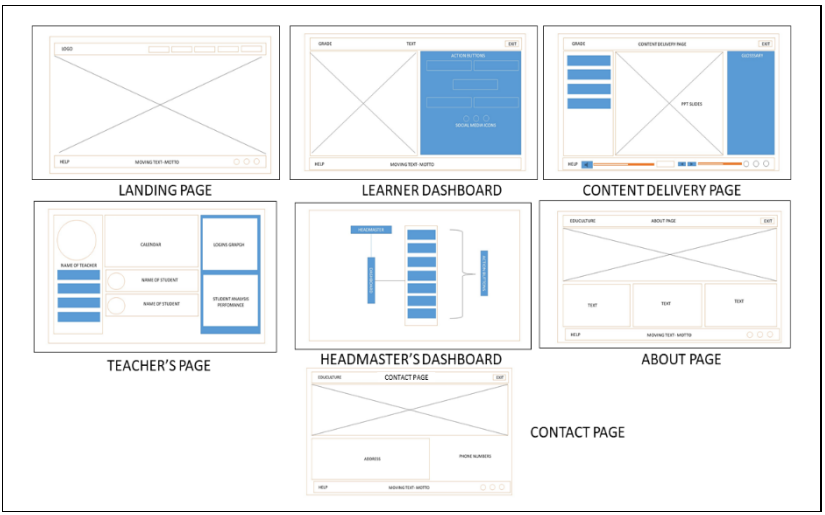

Figure 4: Educulture Wireframe

A vital stage in web design is wireframe design which allows the designer to see how a UI should be organised and structured before devoting time and resources to more in-depth design and development. The wireframe enhances usability, guarantees alignment with project objectives and enables early feedback by delineating key components and their positioning (Harley, 2021). It functions as a guide, allowing the designer to spot possible problems with functionality, content hierarchy and navigation before moving on to low-, medium- and high-fidelity prototypes (Buley, 2019). Wireframes also improve communication between target users, developers and designers, reducing miscommunication and streamlining the design process (Nielsen Norman Group, 2022). Wireframe was essential in the design of Educulture's UI prototype, guaranteeing a user-centred approach that improved the overall educational experience.

Ideation: Low Fidelity Prototype

Figure 5: Educulture low-fidelity prototype

This stage involved developing low-fidelity visual drafts of the Educulture platform, outlining its layout, structure and features. The designer created initial sketches of the UI components, aligning with the research insights and the site map's framework. Concepts were tested and adjusted to enhance usability and minimise potential issues. This

iterative approach allowed for continuous improvement of the design through feedback from both target users and fellow designers.

Prototyping: Educulture Medium-fidelity Prototype (Educulture: https://aitd.co.zw/)

Following the establishment of fundamental elements, including information architecture definition, low-fidelity wireframe development and typography/colour scheme selection, the design process advances to medium fidelity creation. These detailed interface mock-ups evolve directly from the preliminary low-fidelity designs, with Figure 6 presenting the resulting UI/UX visualisation for the Educulture e-learning platform. This phase transforms basic structural concepts into polished, pixel-specific representations that accurately depict the final product's visual hierarchy, interactive elements and aesthetic qualities while maintaining fidelity to the original wireframe framework and user experience objectives. The Educulture medium-fidelity prototype simulates user experience of the finished educational platform, including core features and functionalities as well as providing realistic representation of the final product. In this context, the designed medium-fidelity prototype includes user dashboards, content navigation and feedback tools. The prototype's key strength is its blank slate approach, giving teachers full control to design and upload relevant learning materials, supporting online teaching and syllabus specific content. The research opines that the Educulture e-learning platform is a three-tier platform which supports adjunct learning, blended and wholly online learning, which are major e-learning implementation approaches (Alghathani, 2011). It is also a three-tier in the sense that it accommodates three different types of users performing different tasks, the learners, teachers and administrators.

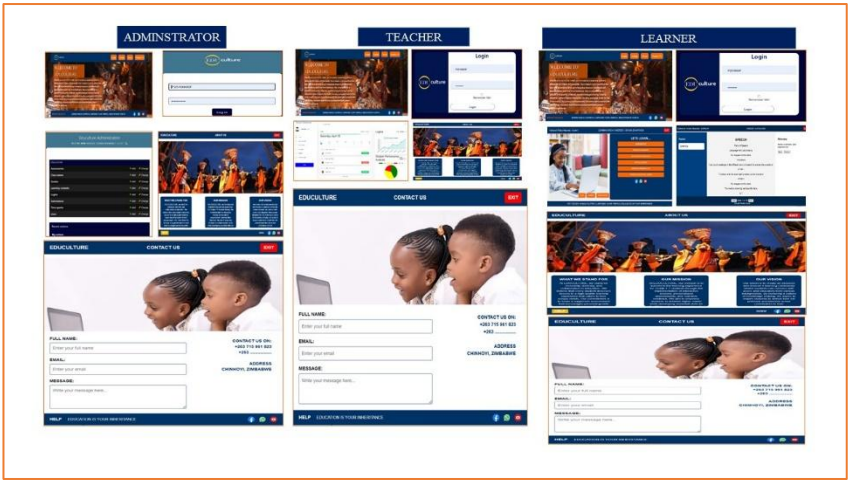

Figure 6: Educulture E-Learning Platform.
Source: https://aitd.co.zw/

The Semiotic Theory has greatly influenced the creation of the Educulture e-learning platform, especially when it comes to the use of Peirce's (1931–1958) triadic model of signs, which consists of the representamen (sign vehicle), object (referent) and interpretant (meaning). This theoretical framework offers a strong basis for comprehending how the platform conveys instructional materials and features to its various users, including administrators, instructors and students. Semiotic principles informed the iterative design process of the platform, which started with low-fidelity paper prototype and progressed to medium-fidelity prototype based on research findings. At the representamen level, the interface elements of the platform act as well-made signs. The logo on the left side of the header works as an indexical sign, showing the platform's identity and creating brand recognition (Nöth, 1990). The four buttons that are coloured orange act as symbols whereby orange represents action and interactivity on the web (Kress and van Leeuwen, 2001). The photos on the home page act as signs that represent Zimbabwean education, creating clear visual associations for local users (Eco, 1976).

The object level of the semiotic triad indicates that the platform is a full e-learning system. It is capable of supporting learning that occurs simultaneously, at different times and a combination of both (Alqurni, 2022). There are three major pages of the platform: Administration, Teacher and Learner. Each major page contains six subpages, totaling 21 pages. This layout is a sign system in which every component signifies various functional areas. To administrators, it is a way of managing users. To educators, it is a means of content delivery and management of students. To students, it is an interactive environment to learn (Norman, 2013).

The interpretant level illustrates how various users interpret the platform's signs according to their professions and cultures. For instance, the login buttons are interpreted differently: administrators see them as means of managing users, teachers interpret them as gateways to teaching resources and learners perceive them as connections to learning materials (Saussure, 1916). The multimedia elements, like interactive quizzes and games support active learning and participation, in line with modern teaching methodologies (Clark and Mayer, 2016). The bottom progress bar shows a marker of accomplishment and the top-right corner exit button follows standard UI conventions, making it easy for all to understand (Peirce, 1931-1958). The semiotic construction of the platform includes its supporting pages. The About page explains the mission and vision of the platform and serves as a meta-sign that places the whole system in the context of Zimbabwe's education system.

The Contact page is an indexical sign that points users to potential lines of communication, while social media icons at the footer are symbolic signs representative of connectivity and extended learning communities (Kress and van Leeuwen, 2001). Semiotically, the structure of content on the website by topics positioned on the left and explanatory remarks seen in sections highlighted in grey on the right is forming a visual syntax that is leading learners through the learning content. This structuring is based on Western reading convention (left-to-right) and the utilisation of color distinction (grey areas) to represent secondary information (Chandler, 2007). The incorporation of Google Slides in

content dissemination is a fusion of sign systems that mix conventional presentation methods with interactive e-learning aspects (Alqurni, 2022).

Semiotic analysis illustrates how the Educulture platform effectively employs various sign systems to produce a unified user experience. However, emerging developments can further improve cultural semiotics through the incorporation of more localised visual metaphors and symbols with strong resonance among students in Zimbabwe (Nöth, 1990). In addition, the platform can be improved with more prominent signifiers focused on accessibility features to facilitate inclusive interpretation from users of varying capabilities (Norman, 2013).

Typography

The Poppins typeface proves ideal for Zimbabwe's Educulture e-learning platform serving Grades 4-7 due to its inclusive design and readability features. It's clear, rounded letter forms enhance comprehension for developing readers, while maintaining cultural neutrality across Zimbabwe's diverse ethnic groups (Walker, 2001; Lupton, 2010). The font ensures consistent legibility across Shona, Ndebele and English with uniform x-height and clean shapes (Legge and Bigelow, 2011), while meeting WCAG 2.1 accessibility standards for students with visual or cognitive challenges (W3C, 2018). Poppins' gender-neutral design creates an inclusive learning environment, making it perfectly suited for the platform's multilingual, multicultural educational context.

Colour Psychology

The Educulture platform's blue-orange colour scheme effectively supports accessibility and engagement for Zimbabwean learners. Blue's cultural neutrality promotes trust and focus (Hallock, 2003), while orange adds energy and creativity (Elliot, 2015), together creating balanced visual stimulation. This WCAG-compliant combination ensures readability for diverse learners while maintaining gender and cultural inclusivity across Zimbabwe's multicultural context.

Participants demographic data

Table 1 shows participant's demographic data

Table 1: Number of Respondents, N=28

	Learners		**Teachers**		**Headmasters**		**Total**
Gender	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	
School A	3	5	3	2	1	0	**14**
School B	5	3	4	1	1	0	**14**
Total	**8**	**8**	**7**	**3**	**2**	**0**	**28**

This section presents detailed demographic data regarding the participants from both School A and School B, including students and teachers. The data highlights key characteristics such as gender, age distribution, grades, experience with e-learning tools and educational qualifications. Hinde (2014) notes that demographic overview enables the researcher to spot patterns or trends within particular subgroups, which helps to contextualise the findings covered in the following sections. According to the demographic information gathered, there are five boys and three girls among the participants in School A and there are five girls and three boys in School B. The balanced gender distribution was found significant in the context of exploring learning preferences related to e-learning interfaces for primary school learners as it allows for an understanding of how different genders may interact with e-learning interfaces. This is crucial in identifying varying preferences that can affect engagement levels (Almasri, 2022).

In addition, this mixed-gender perspective helps to ensure that the design of the e-learning user interface can cater to the interests, motivations and needs of both boys and girls. However, future studies may emphasise potential differences in e-learning preferences between genders. The gender distribution helped to develop the ideal e-learning model and provided information for the study on the likely influences of the interactions between different gender of teachers and learners. Different pedagogical approaches, communication styles and emotional support mechanisms may be used by male and female educators

(Hagenauer *et al.*, 2016). It was noted that learners' perceptions of gender roles and inclusivity in educational resources may be impacted by the experiences of female teachers, which may have an impact on the inclusion of gender-sensitive materials.

The research reviewed that the schools have an e-learning checklist. However, it was noted that on the ground, some of the checklist elements were partially available or not available as shown in Table 2.

Table 2: E-learning Facilities Checklist

Ser	Lab	Internet	Tablets	Power	Interactive Boards	Digital Platform	Digital Content	Comp
Sch A	01	Available	-	Yes	-	-/ W/APP	-	17
Sch B	01	Available	-	Yes	-	-/ W/APP	-	19

The checklist reveals that Schools A and B have different learner computer ratios with School A having one computer for every 32 students and School B having one computer for every 34 students. This indicates that School A has slightly better access to technology for its learners compared to School B.

User testing and feedback

The Educulture platform's user-friendly design has been widely praised for its ease of use and intuitive navigation. Administrators successfully added users in an average of 30 seconds, while content uploads were completed in 40 seconds, aligning with Sauro and Lewis' (2016) usability benchmarks. One headmaster commented:

"The platform is straightforward and easy to navigate once you understand it."

The response highlights the alignment with Norman's (2013) discoverability principle. Similarly, 70% of teachers managed tasks efficiently and learners appreciated the dashboard's organisation, with one stating:

"I like that I can easily access my lessons and see all the subjects in one place."

Despite these strengths, usability challenges exist, particularly for less tech-savvy users. Issues such as password recovery and navigation difficulties have been raised, with a learner highlighting the issue of difficulty in login in if one forgets the password. These challenges emphasise the need for tools to support low-digital-literacy users, as Norman (*ibid.*) warns that systems that overlook user diversity risk alienating those who need the most support. Adding tutorials or onboarding guides, as requested by participants, would address this gap. As one headmaster suggested:

"It would be helpful to have a quick tutorial for new users."

Streamlining navigation and offering guided onboarding would reduce the initial learning curve, as highlighted by Krug (2014). The inclusion of tooltips and help icons, supported by Carroll's (1990) minimal manual approach, would enhance usability further. Providing offline functionality, as requested by 30% of teachers, would also improve accessibility in regions with unreliable internet, reflecting Seale's (2020) principles of inclusive design.

Engagement and Interactivity

The platform's use of gamification elements, such as quizzes, animations and real-time feedback, has significantly boosted learner engagement. Learners praised the instant reward system, with one commenting:

"I enjoy the quizzes because I can see my score right away,"

One of the teachers noted:

"The tests are excellent for rapidly evaluating students."

These features align with Tulsiani's (2024) research on gamification, which highlights how feedback loops and rewards foster motivation and comprehension. Additionally, interactive activities contribute to a low-pressure evaluation culture, enabling continuous engagement. However, several learners expressed a desire for more subject-specific gamification, particularly in science and mathematics. Headmasters from both schools noted that learners remain motivated and involved

through interactive activities, yet the lack of cross-disciplinary gamification limits the platform's potential. Adding math puzzles or science simulations would align with research by Sensei LMS (2024), which emphasises the importance of discipline-specific interactivity. Expanding gamified content across the curriculum would not only sustain engagement, but also enhance learning outcomes. The platform's visual design further supports engagement, with learners and teachers praising its aesthetic appeal. Bright, vibrant colours and intuitive layouts were frequently mentioned, with one learner stating: *"The vibrant colours make me happy as I learn."*

Teachers also appreciated the clear visual cues, such as distinct navigation buttons. However, some learners found the pace of slide transitions too fast, which hindered comprehension. Adjusting slide controls to be learner-driven would accommodate diverse learning speeds, aligning with Kalyuga's (2023) call for adaptive learning systems.

Discussion

The development of the Educulture e-learning platform through an iterative Action Research methodology has yielded significant insights into effective UI/UX design for multicultural educational contexts. This discussion examines the findings through the lens of the Semiotic Theory (Peirce's triad of representamen, object and interpretant) while situating the results within contemporary e-learning design literature. The platform's information architecture successfully established clear signifiers (representamen) that users consistently interpreted as intended (interpretant), evidenced by the 70% task completion rate among teachers. The card-based dashboard design functioned as an effective representamen for subject organisation, with learners correctly interpreting (interpretant) this visual metaphor as access point to course materials (object). This alignment between design signifiers and user interpretation supports Norman's (2013) principles of discoverability, while demonstrating how careful semiotic design can reduce cognitive load in educational interfaces.

Typography selection proved particularly significant in this multicultural context. Poppins typeface served as a representamen of educational professionalism, while achieving successful interpretants across diverse user groups. Learners perceived it as "easy to read", while teachers appreciated its clarity for instruction delivery. The typeface's cultural neutrality (object) effectively avoided ethnic associations that might alienate portions of the user base (Lupton, 2010), making it an ideal symbolic sign for Zimbabwe's multicultural educational environment. This finding extends Walker's (2001) work on typographic legibility by demonstrating how typeface selection carries important cultural semiotics in educational design. The colour scheme's psychological impact reveals interesting semiotic relationships. Blue functioned as an indexical sign (representamen) pointing to trustworthiness (object), with users consistently reporting feelings of calm and focus (interpretant) that aligned with Hallock's (2003) colour psychology research. Orange served as a symbolic representamen for energy, successfully creating the intended interpretant of engagement and creativity (Elliot, 2015). The consistent application of these colours as navigational signifiers established a visual language that users learned to interpret quickly, supporting Mayer's (2017) principles of multimedia learning.

Gamification elements demonstrated the power of interactive signs in educational interfaces. Badges and progress bars (representamen) functioned as symbolic signs of achievement (object), with learners correctly interpreting them as motivational indicators (interpretant). This aligns with Tulsiani's (2024) findings about reward systems, while adding new insights about how gamification semiotics operate across cultural contexts. The immediate quiz feedback (representamen) served as an indexical sign of learning progress (object), with learners reporting increased motivation (interpretant) - "*I can see my score right away*" - validating the importance of timely feedback in educational design (Kumar and Sharma, 2020).

The study reveals important cultural dimensions in interface semiotics. Western-originated UI patterns like hamburger menus initially failed as effective representamen, requiring adaptation to more culturally

familiar navigation signs. This finding challenges Nielsen's (2012) universal usability principles by demonstrating how interface semiotics must adapt to local cultural contexts. The subsequent redesign incorporated navigation elements that better matched users' existing mental models, supporting Norman's (2013) emphasis on conceptual models in interface design. Accessibility features created important semiotic relationships for users with special needs. The high-contrast toggle (representamen) functioned as both an iconic sign (resembling a brightness control) and symbolic sign (representing accessibility), with users correctly interpreting it as a visibility aid (interpretant). This dual semiotic nature made the feature discoverable, while clearly communicating its purpose, addressing the accessibility challenges identified by W3C (2018).

The platform's visual hierarchy established an effective semiotic system for content prioritisation. Size and position (representamen) served as indexical signs of importance (object), with users consistently focusing on larger, centrally placed elements first (interpretant). This successful semiotic communication validates Garrett's (2011) information architecture principles, while demonstrating how visual hierarchy semiotics operate in educational contexts. The iterative design process itself reveals important insights about semiotic evolution in interfaces. Early usability issues often stemmed from mismatches between designers' intended representamen's and users' actual interpretants. Through successive Action Research cycles (Stringer, 2014), these semiotic disconnects were identified and corrected, supporting McNiff's (2017) arguments about participatory design's value. For example, initial icon designs that confused users were progressively refined into clearer visual signs through continuous user testing.

The platform's success in balancing universal design principles with local cultural context suggests a framework for educational interface semiotics. Global UI patterns can serve as conventional signs (representamen's) for functionality (object), while local visual elements provide culturally specific interpretants. This hybrid approach aligns with Singh and Thurman's (2019) call for adaptable learning systems, while offering new insights about semiotic localisation in educational

technology. Technical limitations created interesting semiotic adaptations. The offline functionality (representamen) served as an indexical sign of connectivity status (object), with users learning to interpret its presence as assurance of uninterrupted access (interpretant). This finding extends Seale's (2020) work on inclusive design by showing how technical constraints can generate innovative interface semiotics.

The study's methodological approach also contributes to design research practice. The Action Research framework (Lewin, 1946) proved particularly effective in identifying and resolving semiotic disconnects through its cyclical nature. Each iteration allowed testing of design signs (representamen's) against user interpretations (interpretants), creating progressively more effective semiotic systems. This suggests AR's potential value for other interface design projects requiring cultural adaptation.

Future research directions emerging from this study include investigating: 1) how semiotic systems in educational interfaces evolve with prolonged use; 2) cross-cultural differences in interpreting common UI signs; and 3) the semiotics of adaptive interfaces that change based on user proficiency. The success of this semiotically-informed design approach suggests its potential for other educational technology projects in diverse cultural contexts. The Educulture platform demonstrates how careful attention to interface semiotics, combined with iterative user testing, can create effective learning environments for multicultural contexts. The study advances the understanding of how signs function in educational interfaces, while providing practical insights for designers creating technology for diverse user bases. By grounding design decisions in both Semiotic Theory and real user feedback, the project achieved its goal of creating an inclusive, engaging learning platform that respects Zimbabwe's cultural and educational context.

Theoretical Implications

This study reinforces the significance of the Semiotic Theory, particularly Peirce's triadic model, in the design of culturally responsive

e-learning interfaces. It demonstrates that signs icons, colours and metaphors must be carefully curated to align with users' cultural codes and cognitive interpretations, thereby facilitating more meaningful engagement. The integration of semiotic principles with iterative Action Research underscores the dynamic nature of meaning-making in digital educational environments, emphasising that signs are not static, but evolve through user interaction and feedback. Furthermore, the findings suggest that semiotic analysis can serve as a valuable framework for understanding and improving cross-cultural usability, highlighting the importance of context-specific sign systems in enhancing interpretability and learning outcomes in multicultural settings.

Practical Implications

Practitioners designing e-learning platforms for diverse cultural contexts should prioritise semiotic considerations by incorporating local symbols, metaphors and colour schemes that resonate with learners' cultural backgrounds. The study underscores the importance of iterative user testing and participatory design approaches, such as Action Research, to continually refine signs and interface elements based on real user interpretations. Additionally, emphasising accessibility features and culturally neutral typography, like Poppins, can promote inclusivity and improve comprehension across various learner groups. The findings advocate for integrating cultural semiotics into design workflows to create engaging, intuitive and accessible educational tools that foster learner motivation and reduce cognitive overload.

Study limitations

The study's scope is confined to two primary schools within a specific district in Zimbabwe, which may not fully represent the diverse cultural and infrastructural contexts across the country. The relatively small sample size, focusing primarily on Grades 4-7 learners and their teachers, limits the generalisability of findings to other age groups or regions. The reliance on qualitative feedback and subjective interpretations introduces potential bias, while the short-term evaluation window may not reflect long-term usability or the evolution of semiotic understanding as users become more familiar with the

platform. Technical constraints, such as limited internet access and hardware availability, may have also influenced user interactions and perceptions during testing. To address these limitations, future studies will expand to include rural schools with limited internet access, enabling a deeper exploration of the platform's usability and effectiveness in more resource-constrained settings.

Further Research

Future studies could explore the longitudinal semiotic evolution of e-learning interfaces as users become more accustomed to specific signs and symbols, providing insights into how semiotic systems adapt over time. Cross-cultural research is needed to compare how different learner populations interpret common UI signs, which can inform the development of more universally adaptable or locally tailored interfaces. Additionally, investigating the semiotics of adaptive and personalised learning systems where signs change dynamically based on user proficiency could offer innovative pathways for inclusive education. Expanding research to include larger, more diverse samples across multiple regions could also enhance the robustness and applicability of findings, ultimately contributing to more culturally sensitive and effective educational technologies globally.

Conclusion

The Educulture e-learning platform offers a strong foundation with its user-friendly design, engaging content and support for learner autonomy. It excels in fostering motivation through gamification and providing visually appealing, intuitive navigation, which reduces cognitive friction. However, areas for improvement include enhanced onboarding for new users, expanded gamification across disciplines and more robust assessment tools with detailed feedback capabilities. Addressing these gaps will make the platform more inclusive and adaptable to diverse educational needs. By prioritising user-centred design principles, Educulture has significant potential to lead in the e-learning technology landscape, while supporting effective and personalised education.

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