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# *Designing Digital Learning for Accessibility and Inclusion Across Media*

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***Abstract.*** In the digital revolution of higher education, a significant challenge for higher education institutions is to address the issue of accessibility and inclusion in newly emerging digital learning environments. In this paper, the author synthesize the work of ten empirical studies to investigate how accessibility and inclusion could be achieved in digital learning design. In total, this study analyzed four digital learning design approaches including the assistance of AI platforms, VR/AR simulated environments, Universal Design for Learning (UDL) and digital library systems. Results indicate that immersive technology can be a powerful tool to promote students' engagement, however, students with sensory, cognitive or mobility disabilities may also be excluded by poor usability and sensory overload issues, especially for dyslexic students. The application of AI learning platforms indicates promising potential for personalized and accessible experiences. In addition, digital library and open educational resources can also extend access to diverse learners. Moreover, the UDL model can be an efficient theoretical basis for designing inclusive digital learning, which emphasizes multiple means of representation, engagement, and expression. The paper seeks to make a contribution towards the establishment of sustainable, inclusive and technology based learning ecosystems using multimodal design standards, cross-disciplinary cooperation and institutional support.

***Keywords:*** Accessibility, Inclusion, Digital Learning Design, Universal Design for Learning, Immersive Technology

## 1. Introduction

There is a new development of knowledge creation, access and sharing through the rapid digitalization of higher education. By so doing, virtual classes, online libraries, and AI-based systems have gained a critical role in the learning process in institutions of higher learning [1]. Accessibility, on the one hand, entails the fact that all learners can easily access educational technologies. Inclusion aims to contribute to the active engagement and active representation of everyone irrespective of disability, background, and learning style [2]. Finally, the two notions go hand in hand to promote educational equity in the electronic era.

Nevertheless, the issue of accessibility and inclusion continues to be problematic in other online learning platforms. On the one hand, immersive technologies can be used as the perfect way to increase the engagement of students [3]. Nevertheless, students that have sensory, cognitive or

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mobility impairments can also not be accommodated due to poor usability and sensory overload, in particular among dyslexic students. For example, that such students encountered disparate challenges in VR environments because of sensory overload and usability are worse. Conversely, AI as a learning platform would be able to offer individualized learning and feedback [4]. However, they can also lead to accidental exclusion when the designers fail to consider the principle of accessibility during the creation of algorithms and interfaces. Thus, UDL model turned out to be an effective theoretical framework of developing the inclusive digital learning that focuses on the variety of representations, engagement, and expression. Besides this, digital libraries and open educational resources may also be able to offer a greater variety of access to different learners in case of user-centered and multilingual accessibility options [5].

Despite the above, studies are still fragmented in the field of technology and in the study subjects. It still needs an overarching synthesis to show how AI, VR/AR, and digital repository platforms can bring about an inclusive education together. It also strives to unveil the most frequently encountered challenges, in sum cross-cutting design principles, and lead on future projects that can develop truly inclusive and digital learning ecosystems.

## 2. Theoretical framework

### 2.1. Inclusive education and Universal Design for Learning (UDL)

The theoretical framework of this study is established on two integrated frameworks: inclusive education based on UDL and technology-enhanced multimodal learning. These two frameworks provide an integrated perspective to investigate how a digital learning environment can be designed to accommodate learner diversity and facilitate inclusive learning. Obviously, these two frameworks have a common goal: all learners can access, participate in, and express knowledge in digital learning environment in an effective way regardless of their individual differences [6].

Inclusive education refers to the approach to ensure that all students, regardless of ability, language, or background, can access and participate in learning opportunities equitably [2]. In response to the inclusive education, UDL provides a principled, design-based framework to address learner diversity. It is grounded in cognitive neuroscience and learning sciences and proposes that design for learning diversity should be proactive and account for variability in perception, cognition, and motivation instead of reacting to learning barriers after they have occurred [6].

In digital learning design, UDL can be viewed as a pedagogical principle and technological principle. AI application in adaptive system can be designed as UDL principle, for example, adapt complexity of contents, pace of learning or modality of information [4]. Immersive VR/AR system can be designed as accessible if designers take into account accessibility feature of UDL principle, such as visual contrast customization, audio description, simplified navigation [7]. Therefore, UDL connects inclusive pedagogy and technological innovation. Accessibility should be designed in initial stage of technology development, instead of being treated as a post-process.

### 2.2. Technology-Enhanced Learning (TEL) frameworks

TEL is an extension of constructivist learning theory, which posits that learners construct knowledge through interaction, exploration and collaboration [8]. Digital technologies extend the constructivist idea of learning by enabling visualisation and manipulation of information across sensory channels. In other words, digital technologies can support deeper conceptual learning.

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A multimodal learning perspective posits that meaning is constructed through the interaction of visual, auditory, linguistic and kinesthetic modes [3]. This perspective mirrors the conceptualisation of learning as a semiotic process within multimodal discourse analysis. Multimodal digital learning environments can be designed to engage students through simulation, motion and visualization. Digital learning environments such as VR, AR and AI are constructed to engage students through simulation, motion and visualization. Without accessibility design thinking, multimodal learning increases cognitive load and excludes students with sensory and neurodiversity.

Digital libraries and open educational resources are also constructed with multimodal principles, incorporating text, audio and interactive visual content. When designed with metadata standards, text-to-speech tools and multilingual access, these digital learning objects extend access to diverse linguistic and cultural groups [5].

In summary, TEL and multimodal learning are two perspectives that emphasize active, experiential and socially interactive learning. Both TEL and multimodal learning perspectives emphasize the need for accessibility design principles in every stage of digital learning design [1]. These learning perspectives can be summarised as follows: flexibility, learner agency and intentional design. This study uses these learning perspectives to argue for accessibility and inclusion as design imperatives rather than afterthoughts, and to contextualise discussions of AI, VR or AR and digital repositories with an evidence-based understanding of inclusive learning design.

### 2.3. Integration: multimodal learning and UDL perspectives

The multimodal learning and UDL approaches share an intersection point: they both focus on flexibility, agency of learners and purposeful design. The other two perspectives are based on the pedagogical logic as it offers logic of predicting variability. Technology-enhanced and Multimodal learning approaches add the media logic, giving a structure of designing a flexible and accessible and multimodal learning [6].

Their integration offers the inclusive design of digital learning in three broad directions:

1. Representation Vindication Multiple means of representation as required in UDL are consistent with the interaction of meaning among the senses of multimodal learning. This offers a clue of the visualization of information, hearing or experience.

2. Communication by Interaction: The two schools of thought place importance on interaction. In AI, personalization is cognitive and in VR or AR, sensory. This paper presents that adaptive user interfaces are one of the design considerations of learning.

3. Expression and Participation: Multiple means of expression in UDL is in line with the fact that multiform features of communication are valued in multimodal learning. These forms are voice, gesture and digital media production, not to mention all.

Combining these viewpoints, the proposed study suggests that accessibility and inclusion are design principles and should not be an afterthought. This makes sure that the discourse of AI, VR or AR and digital repositories is based on the evidence-based concept of inclusive learning design.

## 3. Significant problems in digital accessibility

Even though it is clear that there is growing awareness of the ideas of an inclusive design in the area of digital education, a variety of obstacles continue to hinder the development of accessible learning environments. Even though such frameworks as UDL or multimodal learning provide conceptual directions that seem to have a lot of promise, the challenges in their practical use are technology maturity, diversity of users, and institutional capacity. This portion recognizes and examines three

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related very closely issues like inclusivity obstacles VR and AR setting, technical and cognitive load concerns in AI-driven digital learning as well as capacity gaps in accessibility-centered teaching and institutional management.

### 3.1. Inclusion as a barrier in VR and AR space

It has been shown that virtual and augmented reality technologies are potentially very powerful in the context of engaging and experience learning, but they are not always made available to various learner groups. Available studies have suggested that VR and AR technologies can impose considerable visual and kinesthetic loads, including eye strain, motion sickness, and perceptual overload, which are disproportionately experienced by learners who experience visual impairments or sensual sensitivity [3]. Sensually speaking, this overload compromises the inclusive nature of immersive technologies by making engagement a subject when it should have been made an experience. To curb sensory fatigue and ensure usability, adaptive design strategies such as adjustable visual contrast, text-to-speech narration as well as simplified navigation are therefore necessary.

In the light of neurodiversity, as it stands, the majority of existing VR and AR solutions do not need design accommodations for cognitively and attentively different learners. Children with dyslexia or attention problems do not perceive the scene transitions quickly, with many overlaid visual layers, and with multiple overlaying written materials [7]. However, dyslexia-friendly fonts, spatial audio information, or customizable pace are hardly the features covered by accessibility settings. As such, such environments could only end up making the exclusion even bigger or even greater. These practices go against the ideas of UDL, which suggests that one should fight variability in learners rather than addressing it in the future.

Lastly, according to the cognitive load theory, immersive learning may cause a significant mental load when various modes of knowledge are given concurrently without the use of interdependent coordination. Multimodal discourse analysis implies that learning success involves incorporation and not accrual of sensorial information. When visual intensity is accorded more weight than conceptual clarity, the learners are able to divert cognitive resources in manipulating stimuli at the expense of meaning construction. Hence, promoting inclusivity in VR and AR learning should not be considered only in technical terms but in pedagogical terms in the modulation of the complexity of the multimodality of stimulation and understanding.

### 3.2. Technical and cognitive loads in the online platform

The second difficulty is associated with the availability of AI-powered and data-driven learning services. Despite the fact that adaptive technologies or recommendation engines provide a personalization of the learning content delivery process, their rising technological complexity and cognitive load is bound to reduce other groups of learners inadvertently. The non-native language speakers, the geriatric, and the less digitally-sophisticated can find it hard to use a multi-layered interface or interpret the feedback that was created with the help of an algorithm [4].

Badly developed AI dashboards/recommendation engines can provide users with excessive choices, notifications, and visual images. Cognitive Load Theory states that in cases where extraneous processing is more than is allowed in the processing capacity of working memory the learning process will be affected. Specifically, with linguistic and cultural considerations, only those dominant groups can be assisted with their interface language and digital non-feedback mechanisms,

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which reinforce digital inequity in case only those, who use assistance technologies or possess limited interactions streams, can access interfaces.

The algorithms used in personalization are non-transparent and all-inclusive. Numerous adaptive interfaces are adjusted to the level of engagements, but not to accessibility signals. Digital learning tools are usually adaptive, which does not take into account learners with assistive technology, or with limited interaction flows [9]. As an example, text summarizing tools may not be compatible with the screen reader or may produce extremely complicated sentences that would present extra cognitive burden to the learners with multiple languages.

These user-centered assessment requirements are to be covered by inclusive AI design relying on the guidelines of UDL. Adaptive interfaces are supposed to be effective and fair. Extraneous load can be reduced in transparent algorithmic design and multimodal feedback (e.g., visual summaries with audio descriptions), and can serve to support understanding between groups of learners. Nevertheless, the method demands a long-term partnership of educators and engineers with accessibility experts, which is not practiced at the moment.

### 3.3. Minimal teacher education and administrative backing of accessibility-orientation in online education

Despite the ongoing development of digital accessibility technologies, the practical use of these technologies in the educational process is limited to various factors, such as the lack of teacher training, the generation of false assumptions about the inclusive pedagogical approach, and the absence of supporting structures within an institution.

The lack of teacher training in inclusive digital pedagogy is one of the challenges that has been encountered. Although UDL can be mentioned in policy, teachers do not necessarily have the hands-on expertise to implement these ideas in the design of digital courses or assessment procedures [6]. Consequently, the concept of accessibility is often regarded as an extension of the traditional practice instead of a part of the curriculum design.

Inclusive practice is also subject to teacher beliefs and their self-efficacy. The studies are revealing that educators have a low opinion of the accessibility tools in general and regard them as technical or even peripheral to pedagogy, especially when they are provided independently of an institutional recommendation [1]. Without professionally supporting adaptive learning design, a teacher will tend to use only those modalities that are familiar and too focused on text, therefore, excludes learners with disabilities or multilingual requirements unintentionally [9].

Institutionally, this is also exacerbated by the lack of institutional accessibility policies. Online courses or university-wide courses do not have universal policies on accessibility auditing, assistive technology or generation of inclusive content [5]. The policies that exist are usually prepared by other departments thus are not within the responsibility of institutions. Various universities have their policy of accessibility being mainly developed by the technical service unit or the student affairs office with little to no consultation with teaching and curriculum design departments. The resulting effect of this functional fragmentation is what we can call an institutional silo effect, whereby accessibility criteria are not able to permeate course approval, content design and pedagogical evaluation processes. Consequently, this is why inclusion principles tend to be marginal to the fundamental academic mission instead of being incorporated in day to day practice of teaching and learning. Such disunity within an organization is the opposite of the UDL stance that inclusion should be viewed as a systemic as opposed to a personal issue.

Such institutional gaps can be resolved through making accessibility a part of the larger digital transformation programs. Productive models combine digital infrastructure and cross-disciplinary,

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inter-disciplinary, cross-faculty, and cross- disciplinary professional learning community that enables the collaboration between policy makers, technologists, and educators [4]. The other approach includes the rewarding of inclusive innovation using recognition, grant, or accreditation criteria that may foster an access culture lifestyle rather than merely compliance. Otherwise, even the strongest technological innovations remain intermittent and improperly used in another form of recreating exclusion.

## 4. Design principles and strategies

There must be pedagogically-based strategies that would bind together UDL and multimodal learning theory. In this segment, four strategies are suggested which operationalize inclusion in digital media. These are strategies which are distinguishable in terms of focus yet join in order to achieve an integrated design.

### 4.1. Course design based on the UDL: sequential principle of modality

UDL provides a key point-off to design flexible digital learning facilities that will meet the needs of diversity among learners. Under this scheme, there is the Sequential Modality Principle, which holds that presentation of information in different modalities should occur in a series rather than in parallel. Sequential presentation distributes processing demands among the sensory channels which decrease unnecessary cognitive load and enhance understanding.

An example of a virtual biology lesson consists of a start in audio, then powerful graphics are shown, and the lesson ends with a text. The information is delivered in a sequence giving the learner an opportunity to process information in a gradual and manner that best applies to their cognitive profile. The order of presentation to the learner must be facilitated by the learner, in matters of the rate and the sequence of modality. The learners are supposed to have the free will to select which modality they are involved with, along with the sequence they participate in it. This is especially significant among students who have dyslexia, attention differences and faster or slower processing pace [2]. Through this, UDL is enlisted to be an evaluation design principle which promotes cognitive accessibility based on sequential multimodality.

### 4.2. AI integration: transparent adaptivity framework

Artificial intelligence can be used to make learning processes more personalized but the technology also introduces some vital ethical and inclusion issues. The Transparent Adaptivity Framework is a framework whereby AI systems are controllable and explainable. It ensures that the adaptive adjustments like text simplification, difficulty adjusting, or customized feedback should be explained straight to the learner including the reasons to change it. Of great significance, students should be allowed to remember the skills of adjusting, switching on, or disabling these accommodations to maintain autonomy and agency. With a focus on transparency and control by learners, this framework transforms AI into an active and responsible partner of a learning process and not a closed-system algorithmic process. The literature on explainable artificial intelligence in education also includes recent studies that emphasize the fact that transparent and interpretable AI processes should be used to foster trust, ethical responsibility, and learner control in adaptive learning settings [10].

As an example, it is possible to use writing assistant AI explaining the reasons why it made a sentence easier and allowing learners to repair the original text. Similarly, one should ensure

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selection criteria are transparent, which is the main objective of recommendation systems, to prevent bias. These steps are essential to incorporate the idea of relative linguistic and cultural diversity into the data sets to eliminate the concept of exclusion with an algorithm [4]. By balancing between personalization and learner agency, AI as an open partner, not an opaque teacher, projects the concepts of UDL into the digital intelligence.

### 4.3. Immersive media: sensory calibration approach

Rich experiential learning is highly possible with immersive technologies like the virtual reality and augmented reality (VR/AR). The problem of immersive technologies however also has sensory and cognitive issues. According to the Sensory Calibration Approach, a design that is adaptable should be designed to consider various neurological and physical requirements. Students are expected to regulate the level of brightness, motion, contrast and audio level, to avoid being overloaded. It is also noteworthy that it is also essential to incorporate inbuilt pedagogical scaffolds like guided prompts, reflection checkpoints, or simplified navigation, which will allow learners to overcome overload. As an example, in a VR experiment on chemistry one can occasionally stop, and take a few seconds of brief conceptual survey. Visual realism but not usability is the primary concern of many VR educational applications at the moment,accessibility is a design aspect and not an aesthetic one in VR. Continuous user testing of the neurodiverse individuals will prove imperative so that the immersive learning process becomes interesting and accessible.

### 4.4. Digital libraries: semantic accessibility

Both open educational resources (OER) and digital repositories increase knowledge accessibility. Nevertheless, the diversity of these repositories is determined by their design and description. It is our contention that the concept of digital libraries needs to be reorganized as a system of adaptive access by detailed metadata and multilingual design [5]. The metadata must define the reading level, type of format and compatibility with the assistive technology in order to allow the learners to filter the content based on necessity. By using semantic search and dynamic summarization applications, we are able to create levels of overviews of a content, short abstract, outlines, and detailed summaries to meet varying literacy levels. Multi lingual design can also be used so that the digital libraries can be read even by people who cross linguistic barriers. These measures would be able to help repositories evolve into dynamic learning environments that would facilitate equitable knowledge accessibility.

## 5. Conclusion

Digital learning relies on a multilayered design approach, which covers technology, pedagogy, and policy. This study has also developed an argument by the author that the accessibility cannot be mitigated into a technical solution or cosmetic option but needs to be understood as a systemic pledge in the planning of digital education. Ease of access demands the alignment of the developers, educators, and institutions to provide accessibility as a natural result of educational innovation, not a side finding. It has been demonstrated that immersive media and AI present new possibilities of interaction and personalization. Nonetheless, the technologies are presently undermined by lopsided availability practices and non existent regular planning conventions. And unless a strategic approach is put in place that takes into consideration the usability and cognitive load, the potential of

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technological innovation may actually develop the inequities in education instead of addressing them.

Development in the future, in its turn, must lead to the interdisciplinary collaboration between,educational technology, design, and special education. It should be made to include sustainable accessibility of international accessibility standards and evidence-related design processes. Also, the training on inclusive pedagogy should be strengthened among teachers, and students should be involved into participatory design activities.

Ultimately, the digital learning should be transformed into a not a single occasion of learning to everybody but a consistent, continuous learning to everybody. It is a worthwhile goal to have this ecosystem where the diversity is not introduced at the tail-end of the design, but is created as a part of the system instead.

## References

[1] Lomellini, A., Lowenthal, P. R., Snelson, C., & Trespalacios, J. H. (2025). Accessible and inclusive online learning in higher education: a review of the literature. Journal of Computing in Higher Education, 1-24.

[2] Utami, I. S. (2025). Universal Design for Learning in Online Education: A Systematic Review of Evidence-Based Practice for Supporting Students with Disabilities. IJLTER. ORG, 24(3), 94-116.

[3] Lin, X. P., Li, B. B., Yao, Z. N., Yang, Z., & Zhang, M. (2024). The impact of virtual reality on student engagement in the classroom–a critical review of the literature. Frontiers in Psychology, 15, 1360574.

[4] Stelea, G. A., Robu, D., & Sandu, F. (2025). AccessiLearnAI: An Accessibility-First, AI-Powered E-Learning Platform for Inclusive Education. Education Sciences, 15(9), 1125.

[5] Anwar, C. R., Febriati, F., Mawarni, S., & Akhmad, M. A. (2024). Enhancing Learning Accessibility through Digital Libraries: A Study on User Orientation, Resources, and Pedagogical Aspects. Jurnal Edutech Undiksha, 12(2), 245-255.

[6] Veytia Bucheli, M. G., Gómez-Galán, J., Cáceres Mesa, M. L., & López Catalán, L. (2024). Digital technologies as enablers of universal design for learning: Higher education students' perceptions in the context of SDG4. Discover Sustainability, 5(1), 473.

[7] Alcalde-Llergo, J. M., Aparicio-Martínez, P., Zingoni, A., Pinzi, S., & Yeguas-Bolívar, E. (2025). Fostering Inclusion: A Virtual Reality Experience to Raise Awareness of Dyslexia-Related Barriers in University Settings. Electronics, 14(5), 829.

[8] Kee, T., Zhang, H., & King, R. B. (2024). An empirical study on immersive technology in synchronous hybrid learning in design education. International Journal of Technology and Design Education, 34(3), 1243-1273.

[9] Marsden, L., Munn, L., Magee, L., Ferrinda, M., St. Pierre, J., & Third, A. (2025). Inclusive online learning in Australia: Barriers and enablers. Education and Information Technologies, 30(4), 5301-5330.

[10] Gunasekara, S., & Saarela, M. (2025). Explainable AI in education: Techniques and qualitative assessment. Applied Sciences, (3).