Inclusive Digital Learning:

CREATING DESIGN PRINCIPLES

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Introduction

The concept of inclusive education, as advocated by UNESCO (UNESCO, 2005), necessitates providing individualised support catering to the specific needs of each learner throughout their educational journey. A global consensus acknowledges the increasing pervasiveness of digital solutions in daily life, driving the need for a systemic shift based on digital transformation. This transformation is crucial for inclusive education systems in particular.

The United Nations 2030 Agenda for Sustainable Development, with its emphasis on Sustainable Development Goals (SDGs), offers a promising framework. It establishes a new paradigm for inclusive and sustainable development, aiming to guarantee freedom from poverty and fear for all individuals, irrespective of background. The principle of "Leave No One Behind" (LNOB) serves as a core tenet within the United Nations Sustainable Development Cooperation Framework (UN Sustainable DG, 2016). The imperative for promoting equitable development permeates all 17 SDGs, including promoting universal, equitable, and inclusive access to education, health, and other vital services (United Nations, n.d.).

The Global Forum of the OECD Future of Education and Skills 2030 project centred on three critical policy areas: access to learning, learning quality, and student well-being. Discussions highlighted the need for curriculum designers to prioritize equitable access when developing digital learning materials. This emphasis underscores the necessity for effective implementation strategies based on inclusive design principles that guarantee appropriate access for diverse student populations (Gottschalk, OECD, & Weise, 2023).

From a European standpoint, inclusivity, equity, and diversity are viewed as concepts intrinsically linked to social justice and the fair distribution of societal rights, resources, and ultimately, power. The social dimension should be central to higher education strategies at the system and institutional level, as well as at the EHEA and the EU level (European Commission/EACEA/Eurydice, 2022). These principles are fundamental values within the European Union and form the core vision for a European Education Area. Digital inclusion in education imposes the minimising of digital inequalities, thereby widening access, and enhancing the quality of teaching and learning with the intent to provide education that is fair and equitable - these are also key objectives of the European Digital Education Action Plan 2021-2027 (European Commission, 2020). Ensuring the inclusivity, equity, and diversity principles is a clear priority of the European Strategy for Universities (ENQA, 2022), which highlights the crucial role of higher education in Europe's post-pandemic recovery and the development of sustainable and resilient societies and economies (European Commission, 2022).

The prevalence of technology in all aspects of society, particularly in education, presents new opportunities to overcome challenges associated with vulnerable participants' inclusion. Therefore, there are academic training opportunities, institutional facilities, learning content, and teaching processes become more inclusive. However, it will be increasingly difficult to ensure that all citizens, including those with low socio-economic status, can contribute to building inclusive knowledge-based societies. Respecting universal design (UD) principles, fostering non-discrimination, ensuring

information accessibility, and promoting gender equality in education delivery are all crucial for achieving inclusivity (UNESCO, 2016).

The Inclusive Digital Education report by the European Agency for Special Needs and Inclusive Education (2022) emphasizes the ultimate vision for inclusive education systems. This vision entails ensuring that all learners, regardless of age, have access to meaningful and high-quality educational opportunities within their local communities. This necessitates a systemic transformation across all levels of the education system. Furthermore, it requires the application of a user-centred design approach that embraces UD principles and deployment of assistive technologies (AT), when universally designed technology is insufficient, to prevent exclusion in digital education by avoiding drawbacks like poor usability, high costs, or lack of IT support (European Agency for Special Needs and Inclusive Education, 2022).

Educational institutions are becoming increasingly diverse, with learners possessing a wide range of backgrounds, cultural and gender identities, first languages, socioeconomic statuses, ages, abilities, learning preferences, and other characteristics. The presence of heterogeneous learners requires the implementation of inclusive instructional design practices that address the spectrum of learning styles and requirements. Moreover, the proliferation of digital technologies in education, encompassing diverse TEL (Technology-Enhanced Learning) implementations like blended learning, online courses, simulations, virtual classrooms, and mobile learning, necessitates a paradigm shift based on the effective application of inclusive design principles and frameworks towards ensuring the learning environments, teaching materials, and educational services that are universally usable by all students, to the maximum extent possible.

Many proactive approaches discussed in the literature consider a broad audience in design practices related to digital education. These methodologies encompass inclusive design (Inclusive Design Research Centre, n.d.), accessible design (Centre for Excellence in Universal Design, n.d.) and universal design (Interaction Design Foundation, n.d.) (UNESCO, 2005), (Center for Applied Special Technology, n.d.).

The subsequent sections of this report, informed by the growing body of research in the domain, present some design methodologies employed to prevent exclusion in digital education widely adopted internationally.

Universal Design

Several methodologies exist to ensure designs achieve usability for a broad user base. However, universal design (UD) stands out by providing a well-defined set of principles. These principles function as a prescriptive framework, guiding the design process from conception to final evaluation.

Universal Design- Fundamentals

The seminal definition of universal design (UD) emerged in 1997, established by a collaborative effort at the Center for Universal Design at North Carolina State University (Vinney, 2021). This working

group, comprised of architects, product designers, engineers, and environmental design researchers, defined UD as: "The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialised design."

UD has its origins in architecture and industrial design but has recently expanded to include digital products and services and this foundational definition remains the cornerstone of UD principles today.

The Disability Act 2005 defines Universal Design, or UD, as (Centre for Excellence in Universal Design, n.d.):

- The design and composition of an environment so that it may be accessed, understood and used to the greatest possible extent, most independently and naturally and in the widest possible range of situations without the need for adaptation, modification, assistive devices or specialised solutions, by any persons of any age or size or having any particular physical, sensory, mental health or intellectual ability or disability, and
- In the context of electronic systems, a design paradigm that leverages electronic processes to create products, services, and systems ensuring their inherent usability by a broad range of individuals.

Through the lens of UD, the creation of teaching and learning experiences can be re-conceptualized as the systematic development of products and environments that inherently promote usability for a broad spectrum of learners (inclusiveness), with minimal reliance on adaptations or specialized design interventions (accessibility). See the next figure illustrating the main UD determinants.

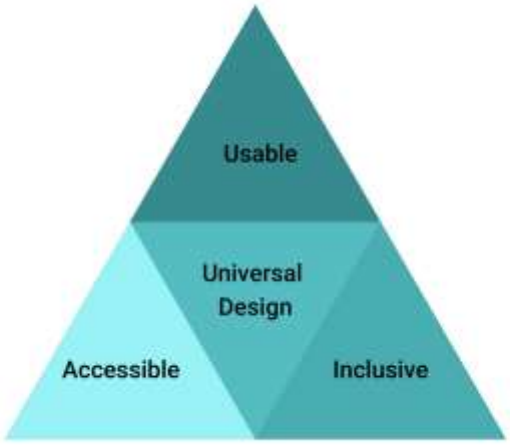

Figure 1 Universal Design Determinants

Source: https://bootcamp.uxdesign.cc/universal-design-the-need-for-assistive-accessible-technology-63090b452cc1

Universal Design and Inclusive Design

Universal design and the related concepts of inclusive design and accessibility (Ivey, 2022) are frequently intertwined, while they possess distinct nuances.

Universal and inclusive designs encompass a broader aim: catering to the needs of a diverse user base, irrespective of their characteristics or identities.

Accessibility focuses on design solutions addressed to the needs of individuals with physical and cognitive impairments. Accessibility is "an integral part of inclusive and universal design. While inclusive design and universal design both cater to the widest range of users, universal design strives for a single solution to cater to everyone, while inclusive design tries to achieve the goal through multiple adaptations." (Interaction Design Foundation, 2016)

Despite some overlap, universal and inclusive design are not interchangeable terms. UD strives to achieve a single, optimal design solution that accommodates the widest range of users possible. This inherently acknowledges that some degree of exclusion may be unavoidable. In contrast to UD, inclusive design aims to develop solutions that prevent the exclusion or marginalization of any user group. This may necessitate the development of multiple design solutions to meet different user needs.

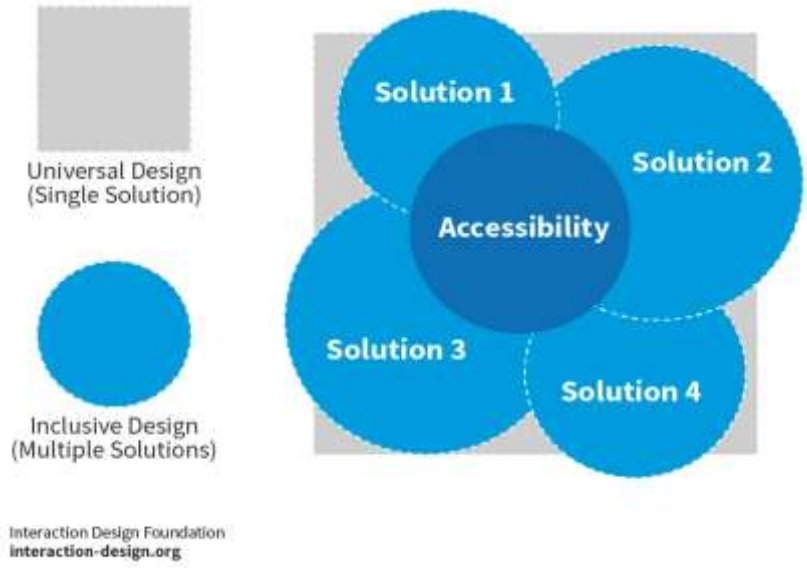

Figure 2 Universal Design vs. Inclusive Design vs Accessibility
(Interaction Design Foundation - https://www.interaction-design.org/literature/topics/inclusive-design)

Universal Design Principles

Universal design aims to exceed minimum standards in an effort to guide design that is fit for purpose and which can be used by the broadest range of people. UD offers a well-defined set of principles that guide the design process towards achieving inclusivity. Inclusive design, on the other hand, emphasizes a user-centred approach, advocating for the direct participation of a diverse range of individuals within the design process itself.

The seven UD were formulated by a team of architects, product designers, engineers, and environmental design researchers under the leadership of the late Ronald Mace in 1997.

These principles serve as a comprehensive framework for designing inclusive environments, products, and communication systems and are efficiently integrated into the teaching and learning paradigms.

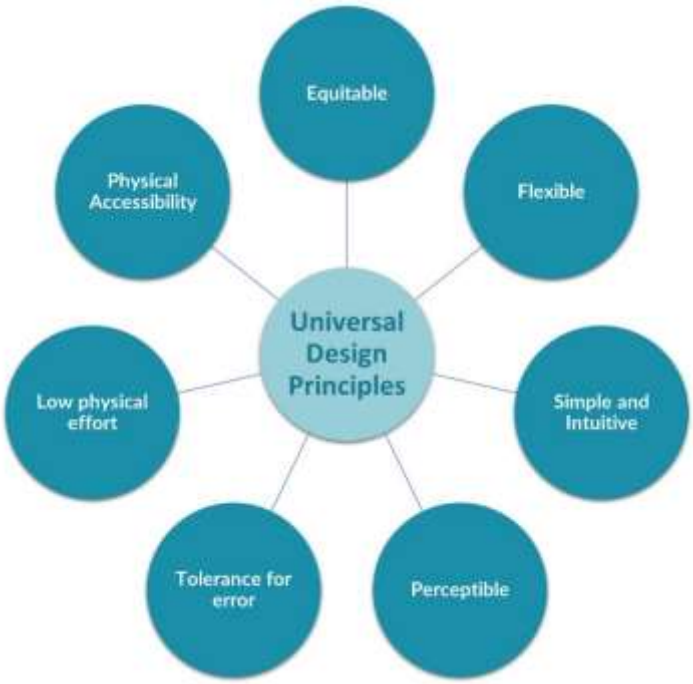

Figure 3 Universal Design Principles
Source: https://www.adcet.edu.au/disability-practitioner/student-access/accessible-amenities

The seven principles of Universal Design and the guidelines underpinning them are as follows (Centre for Excellence in Universal Design):

Principle 1: Equitable Use - guidelines

- Provide the same means of use for all users: identical whenever possible; equivalent when not.
- Avoid segregating or stigmatizing any users.
- Provisions for privacy, security, and safety should be equally available to all users.
- Make the design appealing to all users.

Principle 2: Flexibility in Use

- Provide choice in methods of use.
- Accommodate right- or left-handed access and use.
- Facilitate the user's accuracy and precision.
- Provide adaptability to the user's pace.

Principle 3: Simple and Intuitive Use

- Eliminate unnecessary complexity.
- Be consistent with user expectations and intuition.
- Accommodate a wide range of literacy and language skills.
- Arrange information consistent with its importance.
- Provide effective prompting and feedback during and after task completion.

Principle 4: Perceptible Information

- Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
- Provide adequate contrast between essential information and its surroundings.
- Maximize the "legibility" of essential information.
- Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
- Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

Principle 5: Tolerance for Error

- Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.
- Provide warnings of hazards and errors.
- Provide fail-safe features.
- Discourage unconscious action in tasks that require vigilance.

Principle 6: Low Physical Effort

- Allow the user to maintain a neutral body position.
- Use reasonable operating forces.
- Minimize repetitive actions.
- Minimize sustained physical effort.

Principle 7: Size and Space for Approach and Use

- Provide a clear line of sight to important elements for any seated or standing user.
- Make reach to all components comfortable for any seated or standing user.
- Accommodate variations in hand and grip size.

- Provide adequate space for the use of assistive devices or personal assistance.

The table below presents the definition of the principles, explanation of each principle as well as examples of the use of these principles in the education domain.

UD Principle	Definition	Explanation	Example
Equitable use	**The design is useful and marketable to people with diverse abilities.**	**The design should be universally usable, fostering inclusivity for all individuals irrespective of their background or capabilities. Crucially, this principle necessitates the absence of exclusion or marginalization of any user group. Furthermore, the design should prioritize the user's sense of privacy, security, and safety during interaction.**	**For example - high contrast should be used in digital designs to ensure colour-blind users can see all the content on a screen.**
Flexibility in use	**The design accommodates a wide range of individual preferences and abilities.**	**Users should be able to go at their own pace and accurately complete tasks no matter what their preferred method of doing so.**	**In addition to audio, closed-captioned subtitles should be available for users who want to read instead of listen to what is said in a video.**
Simple and intuitive use	**The use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.**	**Designs shouldn't be needlessly complex, instead, they should work with users' expectations while also providing messaging at every stage of a task to ensure a user knows they are on the right track.**	**When a user goes to the website or app for a streaming service, they should immediately understand how to navigate to the video they want.**
Perceptible information	**The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.**	**Important information should be presented in multiple ways—say through both pictures and words—and designs should be compatible with devices that are used by people with physical limitations.**	**Text in digital designs should never be presented in a long, overwhelming block. Text should be broken up so the most important information is at the top. Bullet points or other methods may also be used.**

Tolerance for error	**The design minimizes hazards and the adverse consequences of accidental or unintended actions.**	**Designs should eliminate or de-emphasize anything that could lead to issues during use. When errors do occur, warnings or other safeguards should ensure a user can undo them or stop the error before it happens.**	**An educational software that provides guidance when the user makes an inappropriate selection employs this principle.**
Low physical effort	**The design can be used efficiently and comfortably and with a minimum of fatigue.**	**Using a computer all day is fatiguing, so designs should minimize effort by making sure users don't have to constantly move their cursor around a page to complete a task or make a task overly complicated.**	**Relevant navigation should be provided, so the user doesn't have to scroll to the top whenever they wish to go to a different part of a website.**
Size and space for approach and use	**Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.**	**Take into account the way the elements of a design are presented on a screen. These elements should be laid out and sized in a way that enables all users to touch, click or manipulate them.**	**We regularly interact with screens that range from very small to very large, but the same website or app shouldn't be presented in the same way on a large computer screen as it is on a small mobile phone screen.**

Table 1 Universal Design Principles

Approach to Applying Universal Design

The Centre for Excellence in Universal Design (CEUD) leverages a framework (model) based on the human ecological systems approach. This approach emphasizes the intricate interplay between individuals and their surrounding environments across various levels, exerting a combined influence on how people develop and react (Centre for Excellence in Universal Design, n.d.):

- Macro level (European/National level) – policies, directives, legislation, awareness campaigns, ensuring the diffusion of UD and its adoption at national and regional levels, and standards such as the Customer Communications Toolkit (CEUD, 2023), ISO/IEC Guide 71:2014 (ISO/IEC, 2014) and EN 301 549, the European standard for digital accessibility (ETSI, 2021).

- Meso level (institutional level) – institutional practices, codes, monitoring/certification, policies and community involvement.
- Micro level (individual level) – recognition of user needs, resources/toolkits, environmental design and technologies including assistive technologies.

The emphasis on inclusive design within this model aligns with the long-term sustainability goals of the UN's SDGs.

Web Content Accessibility Guidelines and the European Accessibility Act

The set of principles to support the UD Framework guide the design of IT used in many products and environments. The World Wide Web Consortium's (W3C) Web Accessibility Initiative (WAI) has spearheaded the development of the Web Content Accessibility Guidelines (WCAG) (W3C, 2023).

WCAG 2.2 (the current version issued in 2023) is an international standard composed of documents explaining how to make web content more accessible to people with special educational needs. It is developed in cooperation with individuals and organisations worldwide, to provide a single shared standard for eContent accessibility that meets the needs of individuals, organisations, and governments internationally.

The European Accessibility Act is a directive of the European Union (EU) which took effect in April 2019. This directive aims to improve the trade between members of the EU for accessible products and services, by removing country-specific rules. The European policy of applying "Design for all" principles on digital technology led to the creation of the European Harmonized Accessibility Standards EN 301 549 which defines "Accessibility requirements suitable for public procurement of ICT products and services in Europe" (ETSI, 2021).

Accessible and Assistive Technologies

Within the educational technology domain, two key concepts are germane to ensuring inclusive access to learning materials: accessible technologies and assistive technologies.

According to the National Center on Accessible Educational Materials at the Center for Applied Special Technology, accessible technologies are “the hardware devices and software that provide learners with access to the content into accessible digital materials” (Center for Applied Special Technology, n.d.).

In contrast to universally designed accessible technologies, assistive technologies address specific barriers faced by learners with disabilities when interacting with educational materials. These tools are designed to bridge the gap between a learner's limitations and the demands of the educational content. Examples include text-to-speech software for learners with visual impairments, screen

readers for those with blindness, and speech recognition software for individuals with motor skill limitations.

Specialised services exist to support learners with disabilities in navigating the landscape of assistive technologies. These services can involve needs assessments, technology recommendations, training on using specific tools, and ongoing support to ensure optimal utilisation of assistive technologies in the learning process.

Web Content Accessibility Guidelines- Four Main Principles

This framework, grounded in four core principles, also known as POUR (Perceivable, Operable, Understandable, Robust), establishes a set of requirements for ensuring the accessibility of IT components.

The POUR principles are the foundation of the Web Content Accessibility Guidelines (WCAG) an international standard for making web content accessible.

Under each of the principles, there are guidelines and success criteria that help to address these principles for people with disabilities (W3C, 2023).

The next figure represents the POUR principles and their success criteria brief explanation.

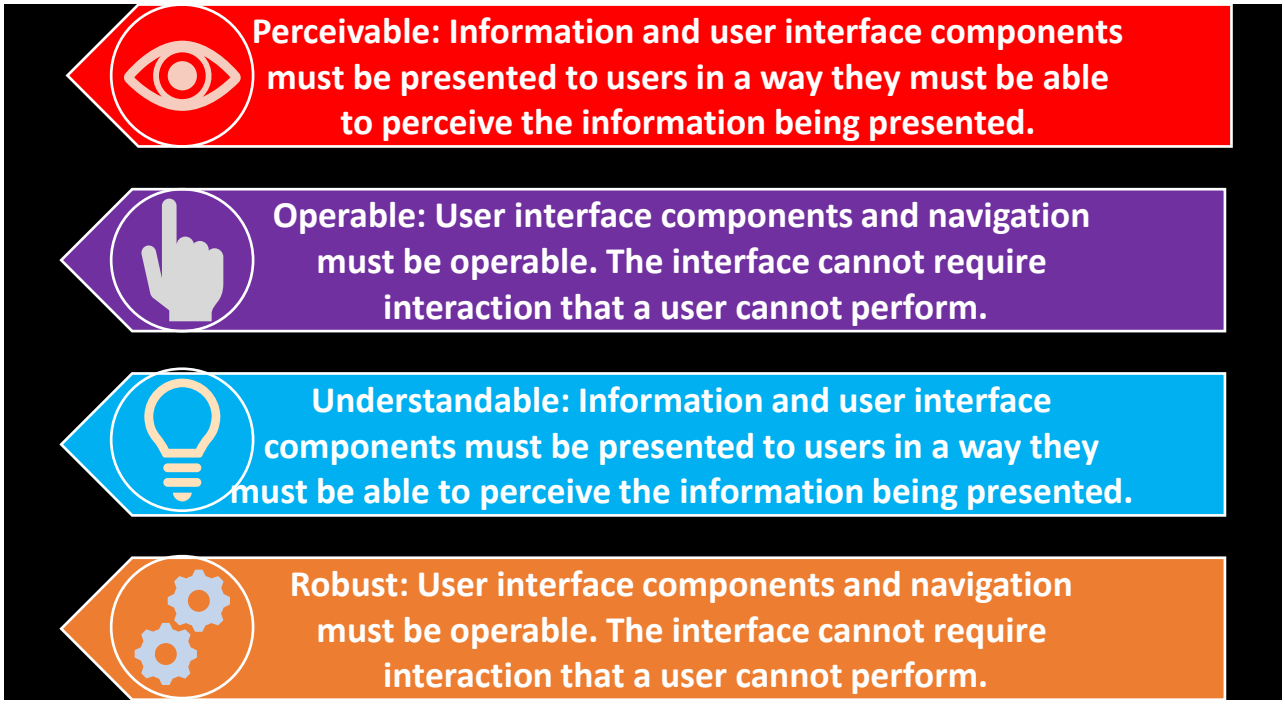

Figure 4 Web Content Accessibility Guidelines - Four Main Principles (POUR)
Source: https://www.w3.org/TR/WCAG22/ (Our design)

The National Center on Accessible Educational Materials (AEM Center) at the Center for Applied Special Technology (CAST) provides a clear and concise explanation of the POUR principles from the education perspective (AEM Center at CAST, n.d.):

- **P**erceivable content: All learners can see and hear the information presented.
- **O**perable content: All learners can navigate the information independently using their preferred tools.
- **U**nderstandable content supports the learners' understanding through a consistent and predictable design.
- **R**obust content works for the learners on a range of current and future technologies, including assistive technologies.

Creating Accessible Content and Open Educational Resources

AEM Center provides guidelines on how to apply the POUR principles effectively to create accessible learning experiences (AEM Center at CAST, n.d.).

To ensure perceivable content, it's essential to present this content in various formats. This way the learners will be empowered to personalize their learning experience by adjusting the information presentation to their specific needs and preferences.

The process of the provision of perceivable content encompasses the following steps:

- Adding the text descriptions to images.
- Including closed captions and transcripts.
- Providing sufficient colour contrast and not using colour alone.
- Creating readable and legible texts.

The techniques for ensuring perceivable content, suggested by AEM Center, are summarized in the next table with the corresponding Web Content Accessibility Guidelines.

Technique	Benefits Learners Who Are	Relevant WCAG Guidelines
Add text descriptions to your images	Blind and use a screen reader; on a slow connection with graphics turned off	1.1.1 Non-text Content (A)
Include closed captions and transcripts	Deaf or hard of hearing; learning English as a second language; accessing videos with poor sound quality or in loud environments	1.2.2 Captions (A)
Provide sufficient contrast	Have low vision; access content in bright lighting or	1.4.3 Contrast (Minimum) (A)

	with the screen brightness turned up	
Do not use colour alone	Have low vision; access content in bright lighting or with the screen brightness turned up	1.4.3 Contrast (Minimum) (A)
Make the text readable and legible	Have low vision, learning or cognitive disabilities	1.4.8 Visual Presentation (AAA)

Table 2 Ensuring perceivable content - techniques and guidelines
Source: https://aem.cast.org/create/perceivable

Operable content requires different navigation options to be provided so the users to be able to navigate and interact with the content: with a mouse, a keyboard or even voice commands.

The steps to make the content operable are as follows:

- Provision of a clear structure with headings.
- Creating descriptive links.
- Check for keyboard accessibility.
- Provision of sufficient time.
- Avoiding content that flashes.

Technique	Benefits Learners Who Are	Relevant WCAG Guidelines
Build a table of contents with headings	Blind, have learning disabilities	2.4.1 Bypass Blocks (A); 2.4.6 Headings and Labels(AA)
Make the links descriptive	Blind	2.4.4 Link Purpose (In Context) (A)
Check for keyboard accessibility	Blind; have motor or cognitive challenges; prefer to use the keyboard to speed up navigation	2.1.1 Keyboard; 2.1.2 No Keyboard Trap
Sufficient time provision	Have motor difficulties that slow responses; require extra processing time due to cognitive disabilities	2.2.1 Timing Adjustable (A)
Avoiding content that flashes	Prone to seizures; easily distracted	2.3.1 Three Flashes or Below Threshold (A)

Table 3 Ensuring operable content - techniques and guidelines (our adaptation)
Source: https://aem.cast.org/create/operable

The understandable content is intuitive and behaves predictably for learners.

This ensures that the learners will focus mainly on understanding the information rather than working around design barriers.

The steps to make the content understandable are as follows:

- Provision of clear directions.
- Consistency, in both the structure and formatting of the information.
- Using plain language appropriate for the reading level of the audience.
- Identifying the language - help screen readers select the correct voice and pronunciation rules.

Technique	Benefits Learners Who Are	Relevant WCAG Guidelines
Provide clear directions	Have learning or cognitive disabilities	3.3.2 Labels or Instructions (A); 1.3.3 Sensory Characteristics (A)
Follow conventions	Have cognitive disabilities	3.2.3 Consistent Navigation (A); 3.2.4 Consistent Identification (A)
Use plain language	Have learning disabilities	3.1.3 Unusual Words (AAA); 3.1.4 Abbreviations (AAA); 3.1.5 Reading Level (AAA)
Indicate the document language	Blind or have learning disabilities and use text-to-speech	3.1.1 Language of Page (A); 3.1.2 Language of Parts (AA)

Table 4 Ensuring understandable content - techniques and guidelines (our adaptation)
Source: https://aem.cast.org/create/understandable

Robust content works on different web browsers and devices (including tablets and smartphones).

The steps to make the content robust are as follows:

- Provision of descriptive metadata.
- Accessibility check performing.
- Testing the accessibility with people.

Technique	Benefits Learners Who Are	Relevant WCAG Guidelines
Provide descriptive metadata	Makes content easier to find and use	2.4.2 Page Titled (A)
Accessibility check performing	Helps prioritize accessibility issues for remediation	Multiple

Involve people in accessibility testing	Makes content usable in more places and devices	Multiple

Table 5 Ensuring robust content - techniques and guidelines (our adaptation)
Soirce: https://aem.cast.org/create/robust

In 2022 National Center on Accessible Educational Materials issued a Protocol for Creating Accessible Open Educational Resources (OER). The purpose of the Protocol is to provide detailed yet easily implemented techniques for creating accessible OER with Microsoft Office and Google Workspace.

The protocol is not intended as a substitute for a full audit of compliance with accessibility standards. It presents the instructional design techniques that can be easily integrated into the processes of developing or modifying educational materials. The Protocol encompasses the following five sections providing explanations as well as practical steps (National AEM Center at CAST, 2022):

- Styles and Document Structure
- Links and Navigation
- Image Description with Alt Text
- Design with Color and Typography
- Evaluation with an Accessibility Checker

Universal Design for Learning

The principles of Universal Design extend their applicability beyond physical environments and products to encompass the realm of teaching and learning. This framework can be applied to learning environments, resources, and instructional methods (Rao, Inclusive Instructional Design: Applying UDL to Online Learning, 2021).

Universal Design for Learning (UDL) was developed in the 1990s and early 2000s by Anne Meyer, David Rose, and their colleagues at the Center for Applied Special Technology (CAST based on the new insights from the learning sciences and creative uses of digital technologies.

UDL is a framework for developing a curriculum that is more accessible for all, including students with and without disabilities. UDL is also intended to guide the development of inclusive learning environments based on the three core principles that aim to ensure that diverse learners, with varying abilities in sight, hearing, speech, movement, literacy, language comprehension, attention, organization, engagement, and memory, can achieve the defined learning objectives (Center for Applied Special Technology, n.d.).

Foundational Concepts of Universal Design for Learning

The UDL framework, used as part of an instructional design process, provides a structure for proactive lesson design, integrating inclusive strategies and options that can support all learners in

the classroom (Meyer, Rose, & Gordon, 2014) at various educational levels and for varied instructional purposes (Rao, Ok, & Bryant, 2014) (Ok & Rao, 2019).

UDL is achieved through the implementation of flexible curricular materials and activities that cater to the individual strengths and needs of a heterogeneous learner population.

Universal Design for Learning acknowledges learner variability as the standard. Recognizing the spectrum of abilities, strengths, experiences, and preferences within any learning group (Meyer, Rose, & Gordon, 2014), UDL provides a framework for proactive support. This instructional design approach allows educators to integrate flexible options from the outset, ensuring inclusivity for a broader range of learners.

UDL's fundamental ideas are related to addressing the following three key issues (Rao, Inclusive Instructional Design: Applying UDL to Online Learning, 2021).:

1) the learners' variability;

2) reducing barriers in curriculum and instruction, and

3) developing expert learners who are purposeful and motivated, resourceful and knowledgeable, strategic and goal-directed.

Core UDL Principles

The Center for Applied Special Technology (CAST) created a set of three principles with roots in cognitive neuroscience to underpin practices and curricula for teaching and learning (Burgstahler, 2021). UDL's core principles are as follows

- Multiple means of engagement. For purposeful, motivated learners, stimulate interest and motivation for learning.
- Multiple means of representation. For resourceful, knowledgeable learners, present information and content in different ways.
- Multiple means of action and expression. For strategic, goal-directed learners, differentiate how students can express what they know.

The figure below presents the core UDL principles and their main determinants (Center for Applied Special Technology, n.d.).

I. Provide Multiple Means of Representation	II. Provide Multiple Means of Action and Expression	III. Provide Multiple Means of Engagement
Perception	Physical action	Recruiting interest
Language and symbols	Expressive skills and fluency	Sustaining effort and persistence
Comprehension	Executive function	Self-regulation

Figure 5 Principles of Universal Design for Learning
Source: http://bookbuilder.cast.org/learn.php

Design Cycle

The UDL Design Cycle (Rao & Meo, 2016) integrates the core components of commonly used instructional design models and processes, such as ADDIE (InstructionalDesign.org) and Backwards Design (Gonzales, 2020). Like the ADDIE process, the UDL Design Cycle begins with a learner analysis and bases instructional design decisions on what is known about the learners. The UDL cycle encompasses six steps presented in the next figure (Rao, Inclusive Instructional Design: Applying UDL to Online Learning, 2021).

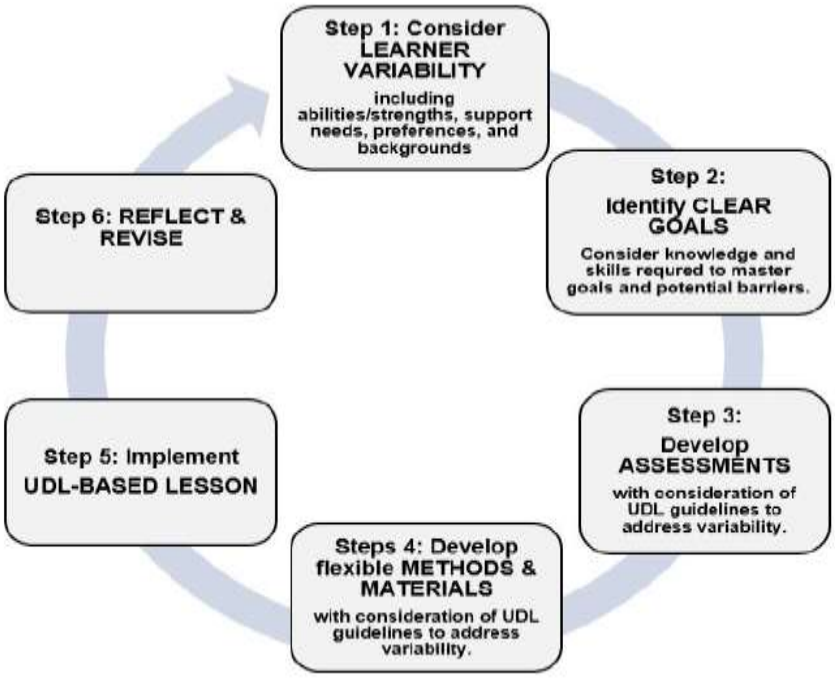

Figure 6 UDL Design Cycle
Source: https://edtechbooks.org/jaid_10_1/preparing_teachers_f

UDL Guidelines

The Universal Design for Learning (UDL) Guidelines outline a range of considerations for designing flexible learning experiences based on the utilization of digital educational resources, interactive content and media. Their core purpose is to minimize barriers and maximize support for all learners. The UDL Guidelines, like the UDL framework itself, advocate for a flexible approach.

The guidelines offer a set of concrete suggestions that can be applied to any discipline or domain to ensure that all learners can access and participate in meaningful, challenging learning opportunities.

The guidelines are structured in the three main categories related to the UDL core principles: Representation, Action and Expression, and Engagement.

- Engagement: Affective factors play a critical role in learning, with learners exhibiting significant variation in their engagement and motivation. Multiple sources contribute to this

individual variability, including neurological factors, cultural background, perceived relevance, subjective experiences, and prior knowledge. For instance, some learners thrive on spontaneity and novelty, while others find such elements unsettling and prefer structured routines. Similarly, some learners favor independent work, while others benefit from collaboration. Consequently, no single motivational approach will be universally effective. Therefore, providing a range of engagement options is essential.

- Representation: Individual learner variability extends to the perception and comprehension of presented information. Effective learning and knowledge transfer hinge on the provision of multiple representations. These diverse formats, encompassing various symbolic systems and sensory modalities, facilitate the creation of connections within and between concepts. In essence, no single representational mode is universally optimal. Therefore, ensuring a range of representational options is critical.
- Action and Expression: Learners exhibit significant variability in their ability to navigate learning environments and demonstrate acquired knowledge. Furthermore, strategic planning, practice, and organizational skills are crucial for effective action and expression, and these areas represent another dimension of learner diversity. Consequently, no single mode of action and expression will be universally optimal. Therefore, providing a range of options for action and expression is essential.

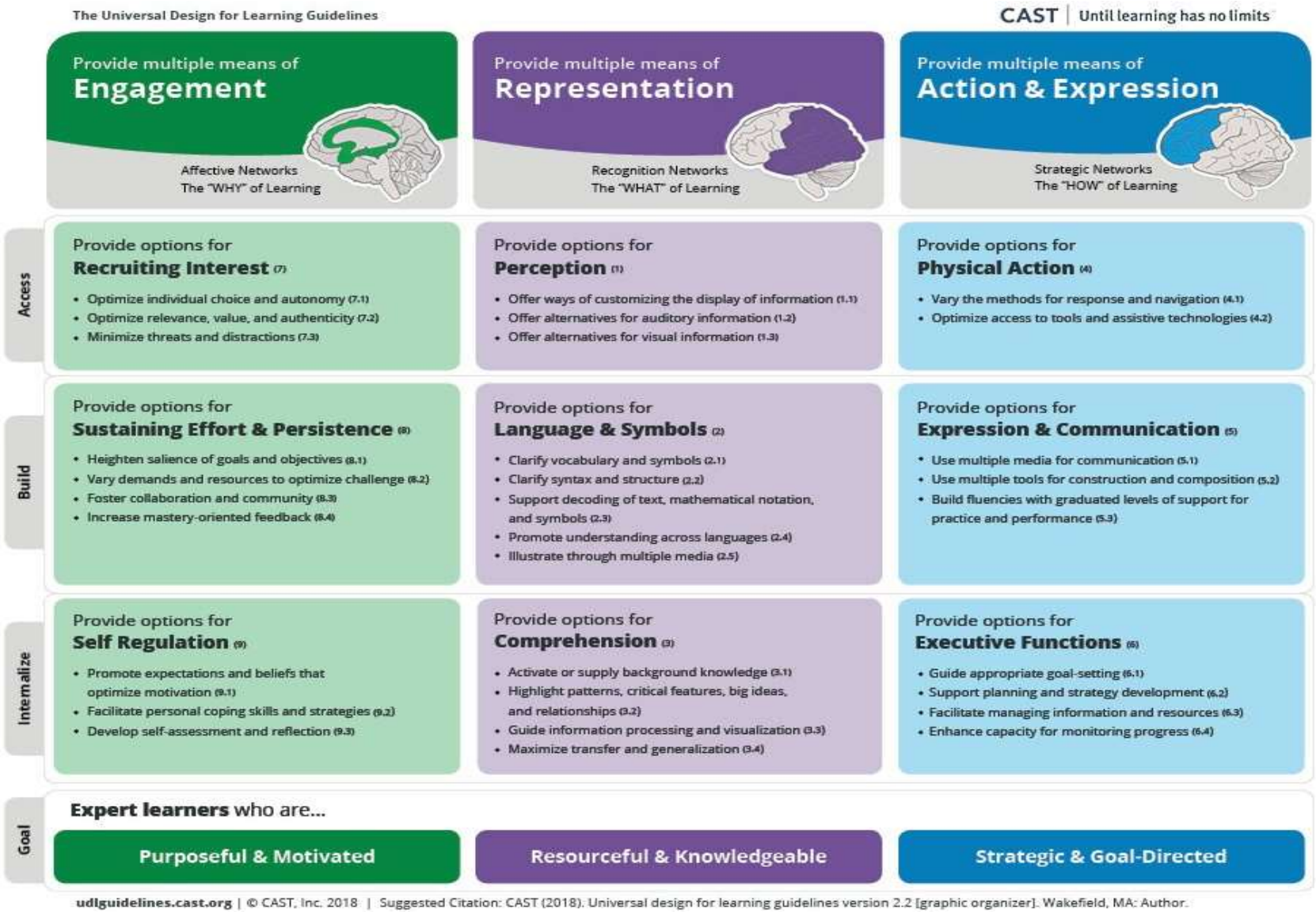

Figure 7 UDL Guidelines

The UDL principles and guidelines possess broad applicability within the educational sphere. They can be effectively utilized across various educational endeavours, encompassing curriculum development, lesson planning, and the design and subsequent reporting of interventions grounded in UDL principles.

Conclusion

From the digital education perspective is clear that while technology offers the potential to present information in a wider range of formats, it can also introduce accessibility challenges for individuals with low socio-economic status, including those with disabilities. Despite the increased access to information, current technologies may not allow all users to interact with learning environments and resources equally.

UDL provides a framework for designing learning solutions focused on the inclusion of all learners and providing opportunities for them to learn effectively.

The WCAG, developed by the World Wide Web Consortium, provide a critical framework for ensuring UDL principles. These guidelines are aimed at both web developers and creators of learning content and educational environments to ensure accessibility to digital content, tools and services for a diverse range of users, including vulnerable learners.

Through UDL principles application adhering to WCAG, technology could be leveraged to implement instructional design practices that proactively mitigate barriers and integrate supportive elements within the digital learning environment, fostering a more inclusive learning experience for all students and empowering them to achieve their full potential.

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DIG-2-INC inclusive digital learning

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