

Applying the POUR Model to Enhance Digital Accessibility in HyFlex Learning Environments

Application du modèle PUCR pour améliorer l'accessibilité numérique dans les environnements d'apprentissage comodaux

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Abstract

The purpose of this study is to advance the accessibility of a hybrid-flexible (HyFlex) learning environment by applying the four attributes of the POUR model (WCAG 2.1, 2018), namely, *perceivable, operable, understandable, and robust*, to make digital learning content more accessible to all learners. The connections between the POUR principles and the principles of four frameworks instrumental to digital accessibility—Universal Design, Universal Design for Learning, Mobile Seamless Learning, and HyFlex—are discussed. The study describes one educator's journey to learn the core skills of making learning resources more accessible to undergraduate students at a teaching university in Switzerland. Qualitative data was obtained from a focus group involving three students, as well as from an external evaluator who conducted a digital accessibility check based on commonly used accessibility criteria. This revealed that the criteria were implemented with varying effectiveness. Findings from the focus group suggest that the instructor's efforts to increase digital accessibility were noticeable. Obstacles were mainly related to navigation issues and the different participation modalities integral to HyFlex. The study offers practical advice for instructors who wish to increase digital accessibility and adaptability in their courses.

Keywords: digital accessibility, digital learning, equitable learning opportunities, HyFlex, mobile seamless learning, POUR model, Universal Design for Learning

Résumé

L'objectif de cette étude est de faire avancer l'accessibilité d'un environnement d'apprentissage hybride flexible (comodal) en appliquant les quatre attributs du modèle PUCR (WCAG 2.1, 2018), c'est-à-dire, perceptible, utilisable, compréhensible et robuste afin de rendre le contenu numérique

d'apprentissage plus accessible à toutes les étudiantes et étudiants. Les liens entre les principes PUCR et les principes de quatre cadres théoriques essentiels pour l'accessibilité numérique sont examinés, à savoir la conception universelle, la conception universelle de l'apprentissage, l'apprentissage mobile sans interruption et le comodal. L'étude décrit le parcours d'une personne enseignante dans un contexte d'enseignement supérieur qui développe les compétences essentielles pour rendre les ressources d'apprentissage plus accessibles aux étudiantes et étudiants de premier cycle dans une université suisse. Les données qualitatives proviennent d'un groupe de discussion mené avec trois étudiantes et étudiants et d'un rapport d'une personne évaluatrice externe ayant effectué un test d'accessibilité numérique sur la base de critères d'accessibilité couramment utilisés. Le test d'accessibilité numérique a révélé une efficacité variable dans la mise en œuvre des critères d'accessibilité. Les conclusions du groupe de discussion indiquent que les efforts déployés par la personne enseignante pour améliorer l'accessibilité numérique ont été remarquables. Les obstacles étaient principalement liés à des problèmes de navigation et aux différentes modalités de participation inhérentes à la formule comodale. L'étude offre des conseils pratiques aux enseignantes et enseignants qui souhaitent améliorer l'accessibilité numérique et l'adaptabilité de leurs cours.

Mots-clés : accessibilité numérique, apprentissage mobile sans interruption, apprentissage numérique, comodal, conception universelle de l'apprentissage, égalité de chances d'apprentissage, modèle PUCR

Introduction

Hybrid education environments offer numerous benefits for traditionally underserved students due to a lack of accessibility. Learners who lack access to technology or have other barriers to participation benefit from flexible access to educational resources, opportunities for interaction and collaboration, and alternative modes of participation in hybrid environments (Cumming et al., 2024). Although technology can be both an enabler and a barrier to effective instruction (Cumming et al., 2024), the increasing digitalization of learning also brings challenges for learners with diverse abilities. Examples include digital and sound or navigation elements that compete for attention on the screen, e.g., moving objects, and have been associated with cognitive overload (Marcus-Quinn & Hourigan, 2022). Similarly, poorly crafted digital materials that ignore accessibility standards limit learner engagement capacity.

Educators need to acquire new skills in designing their instruction to help reduce digital barriers and increase digital accessibility for all learners. Sanderson et al. (2022) grouped digital barriers into four main categories, i.e., perceiving; operating; understanding and language; and other barriers. Auditory and visual barriers prevent learners from hearing or seeing lectures, instructions, learning materials, and the learning environment itself. Operating barriers prevent learners from operating equipment, software, and devices. Understanding and language involve barriers to processing content, tasks, materials, and spoken or written language. Other barriers include different software, formats and devices as well as incompatibility with assistive technology (National Center on Accessible Educational Materials, 2022).

The field of online and hybrid learning would benefit from more research in instructional design that specifically addresses the unique needs of individuals with diverse abilities and that considers a broad range of learning styles and disability types during all phases of content design (Burgstahler, 2021). Familiarization with the principles and practices of web accessibility and Universal Design for Learning is critical to the effective design of accessible and inclusive digital learning environments.

Literature Review

The literature review provides a brief overview of five frameworks instrumental to digital accessibility, (1) POUR (WCAG 2.1, 2018), (2) Universal Design (Center for Universal Design, 1997), (3) Mobile-Assisted Seamless Learning (Wong & Looi, 2011), (4) Universal Design for Learning (CAST, 2024), and (5) HyFlex (Beatty, 2019). These frameworks emphasize accessibility and adaptability, highlighting the importance of inclusivity to ensure effective learner engagement. The frameworks have been researched in isolation rather than in dynamic interaction with other frameworks, with some exceptions. For example, how POUR fits into Universal Design for Learning (UDL) and Universal Design (UD) is well established (Burgstahler, 2021; Nes Begnum & Foss-Pedersen, 2017). Similarly, HyFlex is solidly anchored in UDL (Cumming et al., 2024). The Mobile-Assisted Seamless Learning (MSL) framework was chosen as an additional framework due to its focus on ubiquitous access and adaptability. Nevertheless, the research on the synergies among the five frameworks still appears to be fragmentary.

Each framework is discussed and similarities across the frameworks are mapped out. Special attention is given to digital barriers and ways to avoid them.

POUR

POUR, framed by the Web Content Accessibility Guidelines (WCAG 2.1, 2018), builds on four dimensions, 12 guidelines, and 61 success criteria. All content units, activities, supporting materials, and assignments need to be *perceivable*, *operable*, *understandable*, and *robust*. Specifically, the goal is for all learners to be able to perceive the content. It must also be operable, enabling all learners to navigate the information independently using their preferred tools. For example, the interface needs to be easily navigable using only a keyboard so that learners are not forced to “tab through a whole list of menus until they can get to the correct link” (Sanderson et al., 2022, p. 360). Content must be understandable to support comprehension through a consistent and predictable design. Content must be robust enough to work on a range of current and future technologies, including assistive technologies (National Center on Accessible Educational Materials, 2022). A working draft of WCAG 3 (2024) was published in December 2024 with similar accessibility requirements as WCAG 2 but with a different structure and broader scope.

Common barriers to accessibility are reported in Sanderson et al. (2022) whose investigation of faculty members’ understanding of UD and web accessibility indicates a lack of awareness of legislation and familiarity with UD guidelines (Center for Universal Design, 1997). The 35 respondents were unfamiliar with the seven UD principles, and only one participant had knowledge of accessibility

regulations. The most observed barriers, as reported in Sanderson et al. (2022), are related to the first attribute of POUR (WCAG 2.1, 2018), namely, perceivable. Reported visual barriers include inaccessibility to learning materials, such as PDF documents, lecture slides, videos, and images in presentations, small font size, and foreground and background colours. Auditory barriers include students not being able to hear lectures, instructions, and explanations given while writing on the blackboard, sound in videos (e.g., no captions), or difficulties arising from people talking too fast (Sanderson et al., 2022). Table 1 provides an overview of POUR, its goals, and examples.

Table 1

POUR (WCAG 2.1, 2018)

Attribute	Goal	Examples
Perceivable	Perceive the content, regardless of the device or configuration.	The design communicates necessary information effectively to the user. Example of a barrier: inaccessible files or links.
Operable	Operate the controls, buttons, sliders, and menus.	Examples of barriers: unable to operate equipment, software, and devices; interface difficult to navigate using a keyboard, without a mouse or track pad; font (avoid serif-font).
Understandable	Understand the content and interface.	Design (e.g., LMS course) makes it easy and intuitive to read. Easy and predictable structure. Example of a barrier: navigation inconsistent and unpredictable.
Robust	Usable across devices, browsers, and assistive technologies.	Examples of barriers: different software, formats, and devices; lack of compatibility; unable to open content in different tools, mobiles, tablets, etc.

Note. Learning Management System (LMS)

The POUR principles are also reflected in UD as they both highlight a shared commitment to perceptible information, flexibility, and inclusivity.

Universal Design

The seven principles of UD include equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort as well as size and space for approach and use (Center for Universal Design, 1997). University students' recommendations for making online courses more accessible in alignment with UD principles include offering multiple ways to gain knowledge, such as through videos paired with printed materials, captioned videos, and text descriptions for all visuals (Burgstahler, 2021). Regarding online discussions, recommendations include defining a specific focus to each discussion question; providing guidance in how to answer the question, engaging in and guiding the discussion; and summarizing responses (University of Washington, 2019). Teachers' recommendations include content presentation using:

1. a consistent layout.
2. sans serif fonts.
3. uncluttered pages with plain backgrounds of high contrast.
4. accessible colour combinations.
5. structured headings.
6. lists using style features.
7. descriptive wording for hyperlinked text even without context.
8. avoidance of PDFs unless designed using accessibility standards.

(Burgstahler, 2021; CAST, 2024; Center for Universal Design, 1997).

Educators' knowledge of these design principles contributes to creating equitable learning opportunities (Nes Begnum & Foss-Pedersen, 2017; Sanderson et al., 2022). Some UD principles are also reflected in MSL. They both highlight ubiquitous, intuitive, and flexible knowledge access.

Mobile-Assisted Seamless Learning

Mobile-assisted seamless learning is an offshoot of mobile pedagogy and is anchored in the idea that learning should be possible anytime from anywhere and on any device. Wong and Looi (2011) have defined 10 widely cited dimensions of MSL with wireless, mobile, and ubiquitous technologies in education. The 10D-MSL encompass formal and informal learning (MSL1), personalized and social learning (MSL2), learning across time (MSL3), learning across locations (MSL4), ubiquitous knowledge access (MSL5), integration of physical and digital worlds (MSL6), combined use of multiple device types (MSL7), seamless switching between multiple learning tasks (MSL8), knowledge synthesis (MSL9), and incorporation of multiple pedagogical or learning activity models (MSL10) (p. 2367). From among the 10 dimensions, MSL3 to 5 as well as 7 and 8 are relevant to the present study. While MSL highlights ubiquitous knowledge access across time, space, and devices, UDL reinforces the importance of designing inclusive educational practices and learning experiences that cater to all learners, including those with diverse abilities.

Universal Design For Learning

Universal design for learning provides a theoretical and practical framework for designing physical and virtual learning spaces that emphasize individual strengths and challenges. The three main principles of UDL, as indicated by CAST 3.0 (2024), should be observed to remove barriers and provide equitable access to all learners. These principles entail providing multiple means of *representation, engagement, action, and expression*. Each principle consists of nine guidelines and checkpoints within each guideline. A total of 31 checkpoints provides specific scaffolding strategies and ideas to help educators make content and activities more comprehensible and engaging for all learners.

Many frameworks overlap with POUR (WCAG 2.1, 2018). For example, perceivable aligns with UDL's representation principle by ensuring that content is presented in multiple formats, thus catering to various sensory needs (Choi & Seo, 2024). Both principles advocate providing options for perception and ensuring that key information is equally accessible to all learners through different modalities and adjustable formats (e.g., zooming features, colour contrasts, sound amplifier to filter or augment sound, and video speed controller). Web content should include text alternatives for non-text content, similar to UDL's representation principle which advocates for diverse representation of information to cater to different learning styles (Burgstahler, 2002). Understandable (POUR) connects with UDL's engagement principle. Both strive for clear navigation and content, and predictable interfaces to create a supportive learning atmosphere that encourages participation and meaningful engagement. This atmosphere fosters learner motivation and reduces cognitive load (Choi & Seo, 2024; Cumming et al., 2024).

POUR's understandable principle overlaps with UDL's action and expression principle. Both principles call for comprehension options by designing and presenting information that scaffolds learners' access to knowledge. For example, learners with dyslexia might benefit from text-to-speech software as a compensatory tool. It has been shown that text-to-speech software helps improve reading speed, fluency, and content retention, which, in turn, increases students' self-efficacy in reading abilities, motivation, and autonomous learning (Raffoul & Jaber, 2023). The UDL action and expression principle also corresponds with the operable (POUR) principle, emphasizing flexible learner options to demonstrate their knowledge in various ways, including assistive technology (Burgstahler, 2002). Similar to UDL, HyFlex is anchored in pedagogical flexibility. Both frameworks complement each other to enhance inclusivity, accessibility, and adaptability.

HyFlex

Beatty (2019) is credited for the popular HyFlex course design approach. *Hybrid* refers to multimodal courses delivered synchronously to online and on-site students. *Flexible* refers to students' choice of participation mode. HyFlex is anchored in four principles, i.e., accessibility, learner choice, equivalency, and reusability. *Accessibility* means that students must have equitable access to all resources and activities to ensure that everyone can interact with the content, their peers, and the tutor. *Learner choice* means that students may choose between participation modes (i.e., on-site, remote synchronous, asynchronous, or offline) for any one session. *Equivalency* means that the learning activities in all participation modes should lead to equivalent learning. *Reusability* means capturing learning artifacts produced by all students, regardless of their participation mode. HyFlex requires that all content, activities, and supporting materials be prepared for multiple participation modes.

Accessibility Principles and Connections

There are clear overlaps between these frameworks. However, there is a lack of systematic research mapping the principles of the five frameworks against each other. Figure 1 provides an overview of accessibility principles. Colours indicate related principles.

Figure 1*Accessibility Principles and Frameworks*

POUR (WACG 2.1, 2018)	UD (Center for UD in Education, 1997)	MSL (Wong & Looi, 2011)	UDL (CAST, 2024)	HyFlex (Beatty, 2019)
Perceivable	Equitable use	Learning across time (MSL3)	Multiple means of representation	Learner choice
Operable	Flexibility in use	Learning across locations (MSL4)	Multiple means of action & expression	Accessibility
Understandable	Simple & intuitive use	Ubiquitous knowledge access (MSL5)	Multiple means of engagement	Reusability
Robust	Perceptible information	Combined use of multiple device types (MSL7)		Equivalence
	Tolerance for error Low physical effort Size and space for approach & use	Seamless switching between multiple learning tasks (MSL8)		

Note. Light grey shading indicates all perception-related principles. Dark grey indicates compatibility-related principles. Darker blue refers to flexibility-related principles. Light blue refers to principles related to understanding and usability. UD=Universal Design, MSL=Mobile Assisted Seamless Learning, UDL=Universal Design for Learning, HyFlex=Hybrid-Flexible.

Several principles and guidelines are related to *perception*. Perceivable (POUR) overlaps with perceptible information (UD) and multiple means of representation (UDL). It also connects with MSL8 because seamless switching is only feasible if the transitions among tasks are perceivable or if activities are properly linked. Several principles and guidelines are related to *accessibility across devices and tools*. MSL7 overlaps with operable (POUR) in that users must be able to operate equipment, software, and devices to access content, and it corresponds to robust (POUR) in that content must be usable across devices, browsers, and assistive technologies. Several principles and guidelines are related to *flexibility and choice*, namely, flexibility in use (UD) and accessibility (HyFlex). These overlap in that the content must be available and accessible for all learners regardless of their participation mode, location, and time. Flexibility in use (UD) overlaps with UDL's action and expression as well as engagement principles. Finally, two principles refer to *understanding and usability*, namely, understandable (POUR) and simple and intuitive use (UD).

Increased awareness of these principles and synergies across the five frameworks supports educators in the intentional design of accessible and adaptable learning environments. Familiarity with these principles also helps to avoid common accessibility errors.

Common Accessibility Errors

McCann and Peacock (2021) report accessibility errors found on the academic library websites of 122 universities. The most overwhelmingly common errors were contrast errors, i.e., the lack of contrast between the text and background colours. The next most common errors were (a) empty links, i.e., links or linked images without associated clickable text; (b) empty headings and missing alternative text; and (c) HTML heading tags without text caused by users trying to insert extra space. According to warnings detected by the Web Accessibility Evaluation Tool (WAVE, 2024), redundant links were the most common accessibility errors, followed by redundant titles, small text, broken same-page links, and underlined text. Links are redundant when two or more adjacent links go to the same location, thus creating extraneous repetition. If both the website image and the following text caption are hyperlinked, they are redundant. Underlined text should only be used for hyperlinks. If text is underlined without a link, WAVE will generate a warning. McCann and Peacock (2021) recommend seeking user input, such as focus groups, on a regular basis to establish institutional best practices.

The reviewed frameworks, along with their principles and guidelines, provide the basis for the implementation of accessible and inclusive practices. Understanding the various principles of web and design enables educators to reduce digital barriers and support inclusive education.

Purpose

The study is framed by the following research question: What are students' perceptions of the digital accessibility of one specific course?

Methodology

Context

With the advent of hybrid teaching, instructional design processes have become more complex. Increasing accessibility during the design process goes beyond “meeting minimum requirements and adding additional functionality for learners with disabilities” (Choi et al., 2024, p. 8). Particularly in HyFlex, each participation mode needs to be considered individually, with students' diverse needs and capacities in mind (Marcus-Quinn & Hourigan, 2022).

Participants

In line with the recommendation by McCann and Peacock (2021) to seek user input through a focus group, the instructor posted a call for participation in a focus group called “Increasing Digital Accessibility & Removing Barriers”, including pre-service primary education teachers. The call informed them about the purpose and the type of questions that they were going to discuss:

- How would you evaluate the digital accessibility of our course?
- How would you evaluate the usability of the content and activities?
- Were there any barriers to accessibility, and what kind of issues did you experience?

Three undergraduate student volunteers (1 female and 2 male) in their third and fourth year, respectively, participated in the focus group.

Procedures

The Moodle course materials were reviewed and revised prior to the semester. Table 2 shows the instructor's implemented changes making the content more *perceivable*, with a few changes regarding the POUR attributes *understandable* and *operable*, and no changes regarding *robust*.

Table 2

Adjustments to Course Materials for POUR Attributes

Area	Changes	POUR
Headings	Consistent heading formats (e.g., heading 1, font increased from 16 to 20; heading 2, font increased from 13 to 16).	Perceivable Understandable
Font	Increase font size from 11 to 12. Change font from serif to sans serif. Remove all italics.	Perceivable Operable
URLs	Change font colour of URLs to blue and use underline. Add QR code for video links.	Perceivable Operable
Images	Add ALT text to each picture and figure. Increase size of all pictures and figures. Hyperlink each key visual for download via the Microsoft Teams folder. Redesign visuals from scratch. Remove grey background shading.	Perceivable Perceivable Operable Perceivable Perceivable
Colours	Replace pastel colours, orange, green, and light blue with contrast-rich colours. Replace multi-colour visuals with white, dark blue, black, white, and bold font.	Perceivable Perceivable
Videos	Create videos with captions. Record 5-minute video introductions for each research article.	Perceivable Understandable
PDFs	Avoid PDFs. Convert content from PDF and WORD files into Moodle <i>Page</i> format to provide flexible zooming options. Replace PDFs by WORD files.	Perceivable Perceivable Perceivable

Several changes were informed by the principles of graphic design (Reyna et al., 2018). The following features were activated in Moodle. The *mark as done* button was enabled for mandatory deliverables to help students track their activity and progress. The instructor demonstrated the collapse and expanded view function during class. In the expanded view, the large number of files and activities could overwhelm students, potentially leading to disengagement due to the chaotic presentation (Reyna et al., 2018). To address this, the instructor applied the concept of proximity by grouping related activities and materials, helping students perceive them as connected (Reyna et al., 2018). Additionally, the instructor enhanced comprehension by adding purposeful visuals and removing those that failed to serve a specific purpose (Reyna et al., 2018).

Infographics and posters (e.g., Visme) were created to bundle information coupled with visuals and zooming features. Figure 2 shows a Visme example with purposefully selected colours, colour contrasts, zooming features, a timing tool, and presenter pointer options.

Figure 2

Example of a Visualization in Visme



Figure 3 displays an example of grouping activities and materials in Moodle. A folder with eight storybooks, a zoomable and downloadable visual, and two video URLs along with written instructions were placed into a single Moodle activity block with the purpose of avoiding cluttered files and to clarify the relationship among these items (Reyna et al., 2018).

Finally, a symmetrical and clean layout was chosen to create a sense of balance and stability (Reyna et al., 2018), supporting consistency and predictability in line with the understandable principle of POUR.

Figure 3

Example of a Visualization in Moodle

Download area: "Interactive Storytelling": 8 Books (pdfs). Mark as done

read clearly and slowly	give time to look at the pictures	pause so that pupils can think, comment or ask questions	vary the pace when the story speeds up	vary the pace when the story slows down	comment on illustrations
involve the pupils	have pupils repeat key vocabulary	use gestures, miming, and facial expressions	vary the tone and volume of your voice	ask pupils to point to illustrations	point to illustrations to focus pupils' attention
ask simple questions	make sound effects	make eye contact	disguise your voice	ask questions that stimulate critical thinking	add dramatic effects
answer pupils' questions	ask pupils to predict	whisper to build up suspense	vary between high and low pitch	ask children to make sound effects	maximize interaction

125%

- Please watch the 1st half of this video prior to today's class: [Interactive Storytelling for very young learners](#). In today's class, you will be discussing the video and posting your thoughts to a discussion forum (in groups). See discussion prompts in the forum below.
- Click on the 'folder' symbol above to access the PDFs of 8 storybooks. We'll need them for practice in today's class.
- Optional: Previous student example of 'Interactive Storytelling': [Camping Spree with Mr. Magee](#) (courtesy of N.K.)

Data Collection

Qualitative data were gathered through a digital accessibility check and a focus group interview.

Digital Accessibility Check

In the first phase, data were gathered through a digital accessibility check of the course contents. A research assistant, serving as the external evaluator, reviewed all learning materials in the Moodle

course. In preparation for this task, the assistant was asked to read previous research (Chodock & Dolinger, 2009; Sanderson et al., 2022) to become familiar with the four POUR attributes (WCAG 2.1, 2018) and the seven UD principles (Center for Universal Design, 1997). The assistant was then introduced to and asked to complete a 13-item evaluation matrix, adopted from an existing checklist (Microassist, 2017) and supplemented by other sources (Akinyemi, 2022; Bureau for Internet Accessibility, 2022; Burgstahler, 2023). The evaluation resulted in a 6,402 word, 26-page report with 21 figures.

Focus Group

In the second phase, a focus group with three undergraduate students was conducted. The focus group prompts were grounded in theory and informed by instructional modifications made prior to the semester. Findings from phase one's digital accessibility check resulted in a revision of these prompts. Next, the instructor and research assistant welcomed the participants. Nine posters with highly visual information about designing for accessibility (UK Home Office, 2023) were posted to a flipchart next to their desks. These posters explained how services can be made for different accessibility needs. Specifically, they provide a list of dos and don'ts when designing for users with low vision, screen readers, dyslexia, hearing impairment, or anxiety, as well as users with physical, mental, or motor disabilities. For example, for users with dyslexia, text should be aligned to the left and the layout consistent. Underlining words, using italics, or writing in capitals should be avoided. Further, materials should be produced in multiple formats and frequent reminders and prompts should be provided. The three participants read the posters prior to the start of the focus group. The focus group interview lasted 46 minutes and was audio-recorded in Audacity. The audio file was transcribed in Otter.ai (2023) and resulted in 7,227 words. After the focus group, 42 screenshots of Moodle components were inserted into the transcript to illustrate the issues that were brought up during the discussion.

Data Analysis

The data were analyzed in two phases. In the first phase, the analysis of the completed evaluation was read multiple times. The evaluator's report revealed major barriers which prompted an in-depth review of the evaluator's recommendations. The key issues were determined based on their severity and frequency. This analysis informed the formulation of the focus group prompts. In the second phase, after the focus group interview, the focus group transcript was reread multiple times and supplemented with 42 figures to enhance understanding. Using the interview transcripts, connections between the key issues identified by the participants and those highlighted in the evaluator's report were identified.

Results

The results reflect the digital accessibility check using 12 criteria from the evaluation matrix, along with insights from the focus group interview with three undergraduate students.

Digital Accessibility Check

The criteria that were effectively achieved include content structure, text, images, documents and other files, adaptability, clear and specific instructions as well as a clean layout with minimal distractions. The criteria that were implemented rather ineffectively include navigation and multimedia. Depending on the course view in Moodle, with the index open or closed (i.e., in the left panel), effectiveness varied dramatically and affected navigation, hyperlinks, and predictability. Table 3 displays a summary of the evaluation matrix (Akinyemi, 2022; Bureau for Internet Accessibility, 2022; Burgstahler, 2021; Microassist, 2017) and shows how well the criteria were implemented (i.e., 2=effectively, 1=partially effectively, 0=ineffectively), including future actions to address the identified issues.

Table 3

Results of Digital Accessibility Check

Criterion	Effectiveness of implementation	Rating	Future action to address issues
Navigation	Ineffective. Hyperlinks and files shown differently in open index view.	0	Redesign Moodle course with index open. Add topics to weekly sections or use tile view. Shorten headers.
Content structure	Effective , except for a few inconsistencies regarding titles and headings.	2	Make headers more distinct. Replace bullet-point lists with numbered lists when order matters.
Hyperlinks	Ineffective in open index view. Effective with open index closed.	0 2	Make hyperlinks perceivable in open index view. Add descriptions as to what can be done with the linked file and what file type it is. Remove underscores, special symbols, dashes, parentheses, hash tags, numbers, and abbreviations in file names. Make linked images visually identifiable. Delete redundant links.
Text	Partially effective. Font size effective and adjustable, but issues with colour and contrast.	1	Improve colour contrast. Eliminate different shades of black and grey. Avoid pastel colours. Use white background instead of coloured background.
Images	Partially effective. Most images with ALT text, but ALT text fails to convey enough relevance.	1	Consistently add ALT text. Provide more precise image descriptions.

Criterion	Effectiveness of implementation	Rating	Future action to address issues
Documents and other files	Partially effective. WORD files logically navigable with formatted headings, proper structure, and clear hyperlinks but without image descriptions.	1	Add image descriptions in WORD files. QR codes in WORD files not paired with instructions (i.e., what to do with the code) and where it leads.
Multimedia	Ineffective. Several videos without captions.	0	Use videos with higher resolution and consistently provide captions or transcripts. Add short written summaries of each video.
Adaptability	Partially effective. Speed of videos adjustable. Content translates mostly well across devices (laptop, tablet, smartphone). PDF files accessed on smartphone: text did not reshuffle. All text in Moodle scalable.	1	Improve adaptive design and responsiveness.
Predictability	Effective for most students. Ineffective in open index view.	2 0	Address navigation issues in open index view.
Clear, specific instruction	Partially effective.	1	Add instructions to downloadable folders. Use bold print of key words or phrases sparingly. Label importance: mandatory, recommended, or optional.
Clean layout with minimal distraction	Effective in Moodle. Partially effective in documents.	2 1	Remove decorative images. Show collapse/expand function to students. Reduce clutter, number of files. Use short titles and short file names. Separate folders for on-site presence and synchronous remote attendance in HyFlex courses. Add tables of content in all WORD files.

Note. Rating: 2=effectively, 1=partially effectively, 0=ineffectively.

Focus Group

The students identified features that they found helpful or confusing and formulated recommendations. The most valued features included predictable features, such as using similar structures for each weekly session, highlighting the current weekly section in Moodle, and keeping navigation simple. The students valued tools that supported their workflow, such as checklist features, the mark-as-done button, blacked out bubbles for completed activities, and due dates automatically

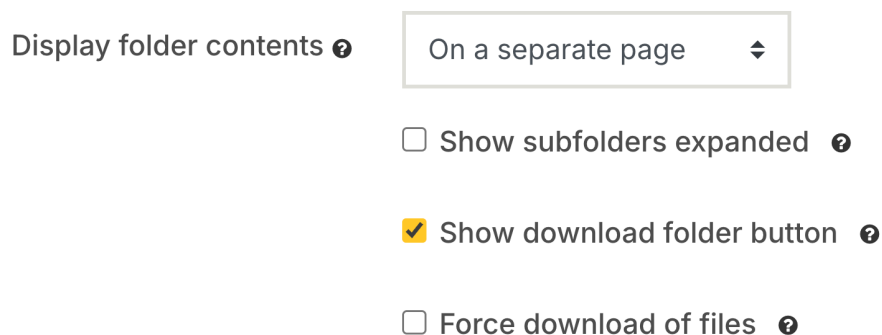
being synced with the calendar. Clear communication and precise labeling, such as *mandatory*, *recommended*, or *optional* were appreciated. These tools were particularly helpful for learners with a strong need for predictability.

The *most confusing* aspect for students was that different teachers used different Moodle designs. This took valuable time to familiarise with and potentially increased anxiety and stress levels. Therefore, focus group participants recommended a more unified, institution-wide approach to LMS course design to benefit learners experiencing stress or anxiety. A major issue was caused by the *open index* view, where most resources and information are presented differently. For example, URLs are not clearly perceivable in this view, which also prevents seamless switching between learning tasks (MSL8). Further, students mentioned feeling overwhelmed with long and multi-part task descriptions and preferred brief video instructions to supplement written instructions. On the other hand, detailed instructions with clearly formulated expectations are beneficial for all learners.

Folders containing multiple files were problematic because their purpose was unclear and the distinction between mandatory and optional tasks was not made sufficiently clear. Similarly, the purpose of several visuals was not clearly communicated, making them seem disconnected from the task. *Forced download* mode within folders was unpopular; students preferred to make download decisions themselves (Figure 4).

Figure 4

Download of Files Not Enforced



Display folder contents ⓘ On a separate page ⌵

☐ Show subfolders expanded ⓘ

☒ Show download folder button ⓘ

☐ Force download of files ⓘ

The HyFlex course format provides all content, activities, and supporting materials for multiple participation modes. However, this complicated efforts to increase digital accessibility, creating new barriers that impaired the learning experience of some on-site students. As a result, the focus group participants recommended creating three separate folders for students accessing the course: 1) onsite, 2) synchronous, and 3) asynchronous. The students expressed a desire for certain accommodations but were unaware that Moodle already offers these accessibility features. Some students, for example, may prefer to access reading materials aurally, which requires enabling the Moodle-integrated text-to-speech plug-in to be enabled.

Discussion

The focus group liked the Moodle course design and felt that digital accessibility was satisfactory and superior to other Moodle courses they had experienced. The instructor's efforts to observe basic graphic design principles (Reyna et al., 2018) had been noticed. The students were satisfied with the clean layout of the Moodle course, its clear structure, the precise and detailed instructions for each session, and the visuals if they supported meaning (Reyna et al., 2018). In contrast to the findings of Sanderson et al. (2022), the most frequently observed barrier types in the present study were not related to perceivable or understandable (POUR) issues. Instead, issues relating to poorly organised content that affected the learners' ability to engage with it echoed a finding by Marcus-Quinn and Hourigan (2022).

Other issues were related to and caused by increased flexibility. Although hybrid environments can reduce barriers by allowing flexible participation to accommodate diverse needs, the HyFlex approach of this course created new issues instead of reducing them, as Cumming et al. (2024) also found. The instructor provided access for multiple participation modalities. Additional files and activities were developed to support synchronous remote participation and bridge the physical-virtual divide during class sessions. However, this led to a significant increase in the number of files, which ultimately undermined the goal of keeping Moodle pages uncluttered (Burgstahler, 2021). The multitude of files overwhelmed the focus group participants and resulted in their disengagement. The risk of cognitive overload caused by digital elements competing for attention on the screen has been mentioned in previous research (Marcus-Quinn & Hourigan, 2022). Further, some files were only useful to the synchronous remote students resulting in confusion for on-site participants. Content presentation in hybrid learning environments needs to be carefully considered to promote universal usability across all participation modes (Beatty, 2019) without creating new barriers. Although the instructor's initial efforts to enhance digital accessibility were partially successful, more advanced training in web and design accessibility is needed.

Conclusion

The study illustrates an educator's efforts to learn the basics of digital accessibility, experience the application of the POUR principles in a HyFlex course, remove digital barriers that students with diverse abilities might encounter, and evaluate the course's digital accessibility and adaptability in collaboration with an external evaluator and three undergraduate students. It presents key elements from POUR (WCAG 2.1, 2018), UD (Center for Universal Design, 1997), MSL (Wong & Looi, 2011), UDL (CAST, 2024), and HyFlex (Beatty, 2019). Many principles are interrelated in terms of how they impact accessibility and adaptability; yet, they all offer a distinctive perspective on accessibility.

The core skills to implement the four POUR attributes can be learned in a relatively short time if the tutorial or self-paced course aligns with the instructor's technical skill level. The perceivable principle is straightforward and relatively easy to implement, especially because one can visually see how well the features have been implemented. Operable appears to be more difficult to apply because it

needs a series of test-runs on multiple devices and browsers and, most importantly, feedback from users (i.e., students, teacher colleagues). Similarly, understandable is more challenging than perceivable to implement because the instructor needs to know learners' individual needs to make pedagogically sensible adjustments. Educators need to carefully consider which accommodations are appropriate for some learners and which might benefit all learners. This requires a familiarization with POUR, as well as an understanding of how these four attributes intertwine with the principles of other frameworks that help advance digital accessibility. In addition, hybrid learning environment educators need to be aware of the HyFlex principles (Beatty, 2019) and how they can be implemented in concert with POUR.

Recommendations

It is recommended that instructors ask students in the first session about any individual learner preferences or needs to maximize their learning experience so that LMS features can be appropriately selected and learning resources adjusted, activated, or disabled. As Marcus-Quinn and Hourigan (2022) state, “accessibility, inclusion, and UDL cannot be treated as add-ons. They must be factored from the very beginning of the design process” (p. 165). For example, only learners with a visual impairment would benefit from viewing an alternate image if the original image provided is difficult for them to process. Another example would be that some students are allowed to see audio files attached to a resource (e.g., in an exam situation), whereas other learners are prevented from viewing them. Learners who experience reading and comprehension challenges may benefit from a feature that converts text to speech (Raffoul & Jaber, 2023). Educators also need to be aware that the robust principle (POUR) needs a time-consuming digital accessibility check across multiple devices to ensure the combined use of various device types (Wong & Looi, 2011). Preferably someone other than the instructor conducts the check to provide a different perspective.

Training is needed for students and educators in how to remove digital barriers and and make use of accessibility features offered by an LMS. Raffoul and Jaber (2023) highlight that the use of accommodations and assistive technology, such as text-to-speech software, demonstrates to students that there are different approaches to learning the same content (CAST, 2024). There are areas where educators can apply quick fixes, such as headings, links, ALT text, tables, colour contrast, lists, video (e.g., speed control, closed captions), audio (i.e., text-to-speech), and accessible PowerPoint slides. Mastering these core skills helps address LMS accessibility issues, with impactful quick tutorials and self-paced modules (e.g., Concordia, 2023; ETH Zurich, 2023; Northwestern, 2023) offering practical guidance. Although tools like the Brickfield Accessibility Toolkit support content checks and alternative formats in Moodle, they cannot replace human evaluation (Brickfield Education Labs, 2024). Students should be given an opportunity to share their experiences and insights on how the accessibility of a course can be improved (McCann & Peacock, 2021).

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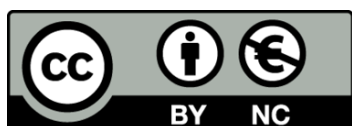
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