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Development of H5P-Based Interactive Videos in the Moodle LMS to Enhance Deaf Students' Understanding of the Inclusive Education Subject

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ABSTRACT

This study developed and preliminarily evaluated H5P-based interactive videos integrated into Moodle to support deaf students' understanding of the Inclusive Education course in higher education. The study responds to the limited availability of accessible digital learning media designed according to the visual learning characteristics of deaf students and the principles of Universal Design for Learning. A Research and Development design was employed using a modified Borg and Gall model consisting of four stages: needs analysis, product design, development and expert validation, and limited product trial. The participants included one content expert, one media expert, and three deaf students enrolled in an Inclusive Education course at an inclusive higher education institution in Surabaya. Data were collected through expert validation sheets and a concept understanding test administered before and after the use of the interactive videos. The product consisted of three H5P-based videos integrated into Moodle, featuring subtitles, sign language interpretation, visual explanations, embedded quizzes, drag-and-drop activities, and immediate feedback. Expert validation showed that the product was highly feasible in terms of content quality, with a mean score of 3.80, and media design, with a mean score of 3.71. The limited trial indicated an increase in students' mean score from 52.3 to 87.7, with an N-Gain of 0.72. These preliminary findings suggest that Moodle-integrated H5P interactive videos have potential to support accessible and interactive learning for deaf students, although broader trials are needed.

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1. INTRODUCTION

The rapid integration of digital technology in higher education has expanded opportunities for flexible and student-centered learning through Learning Management Systems (LMS). Among these platforms, Moodle is widely adopted due to its open-source nature and support for interactive learning environments. However, despite these technological advancements, ensuring accessibility for students with disabilities remains a significant challenge, particularly for deaf students who rely primarily on visual rather than auditory modes of communication (Alshawabkeh, Woolsey, & Kharbat, 2021).

Deaf learners process information predominantly through visual channels such as text, images, and structured representations. This learning profile highlights the importance of designing instructional environments that are visually accessible and cognitively supportive. In digital learning settings, content that depends heavily on spoken explanations or auditory cues can create barriers to comprehension (Aljedaani et al., 2023).. Therefore, the need for visually structured and interactive learning environments becomes increasingly important for supporting deaf students' understanding.

From a pedagogical perspective, these characteristics align closely with the principles of Universal Design for Learning (UDL), which emphasize flexibility in representation, engagement, and expression. For deaf learners, the principle of multiple means of representation is particularly crucial, as it encourages the use of visual, multimodal, and systematically presented learning materials that reduce dependence on auditory information (Yuwono, Mirnawati, Kusumastuti, & Ramli, 2022).

Within this framework, interactive multimedia plays a key role in translating UDL principles into instructional practice (Dzulkifli, 2021). Interactive learning environments enable information to be presented in segmented formats supported by visual cues and learner-controlled pacing. Such environments support active cognitive processing and align with the strengths of deaf learners, who tend to benefit from structured visual input and predictable learning sequences.

One technology that supports this approach is H5P, an open-source framework that allows educators to create interactive learning content such as videos with embedded questions, prompts, and feedback integrated directly into LMS platforms like Moodle (Suarsana, 2021). Through features such as segmentation, visual reinforcement, and embedded interaction, H5P-based interactive videos have the potential to operationalize UDL principles in digital learning environments (Alika et al., 2023).

Previous studies have shown that interactive video can enhance engagement and comprehension among deaf learners (Ahmed & Hasegawa, 2022). However, most of this research has focused on primary or secondary education contexts. Empirical studies examining the integration of H5P-based interactive video within LMS platforms in higher education remain limited.

This gap becomes particularly relevant in concept-based subjects such as Inclusive Education, where abstract ideas require structured and accessible presentation. While LMS platforms are increasingly used in universities, they are not always designed to accommodate the visual learning needs of deaf students (Dzulkifli, Suhid, Fakhruddin, & Ahmad, 2021). As a result, there is a need to develop and evaluate interactive learning media that align with deaf learners' characteristics within higher education settings.

In the Indonesian higher education context, inclusive education policies have expanded access for students with disabilities. Nevertheless, the availability of accessible digital learning media remains limited. This highlights the importance of designing technology-enhanced learning environments that move beyond physical inclusion toward meaningful participation (Riza, Firdaus, Junaeti, Hidayat, et al., 2018).

Beyond accessibility, learning effectiveness for deaf students is closely related to how information is structured and delivered visually. Research in deaf education highlights that visual clarity and logical sequencing significantly influence comprehension. Learning environments that provide segmented information and immediate feedback can support meaning-making processes, particularly when abstract concepts are involved (Amka & Mirnawati, 2020).

In higher education, these needs become more complex due to the nature of academic content, which often requires conceptual reasoning rather than procedural understanding. Courses such as Inclusive Education involve theoretical discussions on diversity, participation, and adaptation strategies. Without appropriate visual scaffolding, these concepts may remain difficult to grasp for deaf learners.

Interactive multimedia environments offer a promising approach to address this challenge. By combining visual explanation, structured interaction, and learner control, such environments support deeper cognitive processing (Lina Mufidah, Rachmawati, & Sulistyani, 2022). Interactive elements embedded within instructional media encourage students to engage actively with content rather than merely consume information passively.

In LMS-based learning environments, interactivity also plays an important role in promoting independent learning. Deaf students often benefit from the ability to revisit material, control pacing, and

process information through visual repetition. LMS-integrated tools that support such flexibility can therefore enhance both comprehension and learning autonomy (Andriyani, Buliali, & Pramudya, 2022).

Despite these advantages, many LMS implementations in higher education still rely on conventional instructional formats such as lecture recordings or text-heavy materials. These formats may not fully accommodate the visual learning preferences of deaf students. As a result, the potential of LMS platforms to support inclusive learning remains underutilized.

The integration of interactive multimedia tools such as H5P within LMS platforms represents a shift toward more responsive digital learning design. Rather than merely delivering content, such tools enable structured engagement through embedded questions, visual prompts, and immediate feedback mechanisms (Nurkholifah, Mindyarto, & Astuti, 2023). This aligns with contemporary perspectives on inclusive digital learning, which emphasize meaningful participation rather than simple access.

Grounded in the intersection of deaf education, UDL principles, and interactive multimedia learning, this study seeks to address the limited use of LMS-integrated interactive video for deaf students in higher education. Accordingly, this study aims to develop and evaluate H5P-based interactive video learning media integrated into Moodle to enhance deaf students' understanding of Inclusive Education material.

2. METHODS

2.1 Research Design

This study employed a research and development method using the Borg & Gall model modified into four stages: (1) needs analysis, (2) product design, (3) product development and validation, and (4) limited trials. This approach was selected as it aligns with the research objective of producing H5P-based interactive video learning media integrated into the Moodle LMS to enhance deaf students' understanding of Inclusive Education material (Azmi, Junaidi, Sripatmi, & Wahidaturrahmi, 2024).

To evaluate the preliminary effectiveness of the developed learning media, the limited field testing stage employed a one-group pretest–posttest design involving three deaf students. This evaluation was conducted as part of the fourth stage of the modified Borg and Gall model, focusing on initial product implementation in an authentic instructional setting. The pretest and posttest were administered before and after students completed the H5P-based interactive video learning activities to examine changes in their conceptual understanding of Inclusive Education.

The learning intervention consisted of three interactive videos delivered over two learning sessions. Each video had a duration of approximately 8–10 minutes and was designed to present key concepts of Inclusive Education using visual explanations, embedded quizzes, drag-and-drop activities, and pause-and-answer interactions. Additional accessibility features included subtitles, visual icons, and segmented content to support comprehension. The videos were accessed asynchronously via Moodle and followed by guided in-class reinforcement activities during the limited trial phase.

The instructional content covered three main topics in the Inclusive Education course: (1) fundamental concepts and principles of inclusive education, (2) characteristics and educational needs of students with disabilities, and (3) inclusive teaching strategies in higher education. Each topic was delivered through an H5P interactive video incorporating visual explanations, subtitles, sign language interpretation, and embedded formative assessments.

The H5P activities included multiple-choice questions, drag-and-drop exercises, fill-in-the-blank tasks, interactive hotspots, and pause-and-answer prompts. Immediate feedback was provided after each activity to reinforce conceptual understanding before students continued to the next segment. Students completed a researcher-developed concept understanding test consisting of 20 multiple-choice items aligned with the course learning outcomes. The test measured four indicators of conceptual understanding: identifying inclusive education principles, distinguishing learner characteristics, applying inclusive instructional strategies, and analyzing inclusive learning scenarios.

During the implementation, deaf students received accessibility support through Indonesian Sign Language interpretation, synchronized subtitles, and lecturer guidance during classroom discussions.

The Moodle platform allowed students to access and replay the videos independently outside classroom sessions.

The description of the research method in this study is as follows.

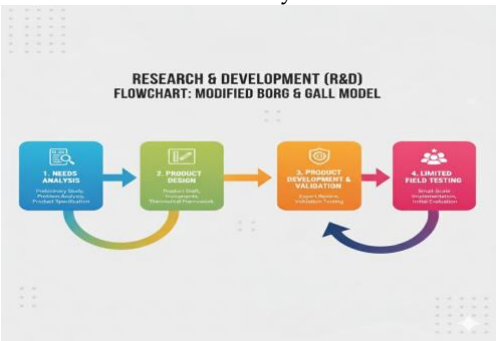

Figure 1. Research & Development Flowchart

2.2 Participants and Sampling

The research subjects consisted of two groups: experts and students. The experts involved were one material expert and one media expert. The student participants were three deaf students enrolled in the Inclusive Education course at PGRI Adi Buana Surabaya University, an inclusive higher education institution in Surabaya. The selection was conducted using purposive sampling, considering the students' communication abilities and comprehension of visual instructions.

The small sample size is consistent with design-based research (DBR) principles, which prioritize iterative development, contextual testing, and in-depth analysis over large-scale generalization during the early stages of product validation. In this approach, limited trials are intended to examine usability, feasibility, and instructional effectiveness within an authentic learning context before broader implementation.

All participants voluntarily agreed to take part in the study. Participation was based on written informed consent obtained prior to data collection. To ensure ethical compliance, all participant data were treated confidentially and reported anonymously.

2.3 Data Collection Instrument

The data collection technique used was a questionnaire to measure product feasibility, and a test to measure the effect of using the development product on deaf students' understanding of inclusive education material. The research instruments included: (1) an expert validation questionnaire to assess the feasibility aspects of content and media in the form of a 4-point Likert scale, and (2) a concept understanding test (pre-test and post-test).

The research instruments included expert validation sheets and student learning outcome tests. Content validity was established through expert judgment involving one material expert and one media expert who evaluated the relevance, clarity, and appropriateness of the interactive video content and design. The validation results indicated that all instrument components were considered appropriate for measuring feasibility and learning effectiveness.

Reliability was examined descriptively based on the consistency of expert ratings and students' response patterns during the limited trial. The expert validation scores showed stable evaluations across assessed aspects, indicating acceptable reliability for early-stage product testing in design-based research. In addition, the pre-test and post-test items were aligned with the learning objectives to ensure measurement consistency of students' conceptual understanding.

2.4 Data Analysis Technique

The data analysis employed two approaches: (1) expert validation, which involved two experts one in content and one in media and (2) measurement of the improvement in deaf students' understanding. The details are as follows.

2.4.1 Analysis of Media Feasibility

Media feasibility data was obtained through a questionnaire filled out by experts. This questionnaire contains statements related to the feasibility of the media with available answer options. The analysis was carried out by collecting expert responses through a feasibility questionnaire, which was then analyzed using a Likert scale of 1-4, after which calculating the feasibility value with the formula contained in this Equation 1.

$$Practicality\ Score = \frac{\sum \text{The score obtained}}{\sum \text{The expected score}}\ X\ 100\%$$

After obtaining the feasibility results through the predetermined formula, the criteria for the mode used by experts can be known. The categories include very feasible, Feasible, less Feasible, and not Feasible, with a feasibility scale presented in Table 1.

Table 1. Product Feasibility Category

Score Range	Feasibility Category
3.26 – 4.00	Very Feasible
2.51 – 3.25	Feasible
1.76 – 2.50	Fairly Feasible
1.00 – 1.75	Not Feasible

2.4.2 Analysis of Learning Outcome Improvement

Student learning outcomes were analyzed using the N-Gain formula (Jacob & Centofanti, 2024) as follows:

$$N - Gain = \frac{\text{Spost} - \text{Spre}}{\text{Smaks} - \text{Spre}}$$

Description:

Post : Average posttest score
Pre : Average pretest score
Max : Ideal maximum score (100)

The learning outcome improvement categories are determined based on the following g values:

Table 2. The Learning Outcome Improvement Categories

Value g	Improvement Category
$g > 0.70$	High
$0.30 \leq g \leq 0.70$	Medium
$g < 0.30$	Low

Based on these two analyses, a learning media product is declared effective if it meets two criteria:

a. The average expert validation result falls within the "Feasible" or "Very Feasible" category; and
b. The N-Gain value for student learning outcomes falls within the "Medium" or "High" category.

3. FINDINGS AND DISCUSSION

3.1 Findings

The results of this study include two main aspects: media validity, and media effectiveness in improving deaf students' understanding of Inclusive Education material through the use of H5P-based interactive videos in the Moodle Learning Management System.

3.1.1 Content Expert Validation Results

The validation conducted by the content expert focused on the accuracy, clarity, and appropriateness of the material presented in the interactive video. The evaluation was carried out using a 10-item questionnaire based on a 4-point Likert scale (1 = Not Feasible, 4 = Highly Feasible). The results are presented in Table 3.

Table 3. Content Expert Validation Results

No	Aspect Evaluated	Mean Score	Category
1	Relevance of content to learning objectives	3.90	Highly Feasible
2	Clarity and accuracy of concepts	3.80	Highly Feasible
3	Suitability for deaf learners	3.75	Highly Feasible
4	Depth and sequence of material	3.85	Highly Feasible
5	Language simplicity and visual clarity	3.80	Highly Feasible
6	Use of examples and visual illustrations	3.85	Highly Feasible
7	Encouragement of student engagement	3.75	Highly Feasible
8	Support for inclusive attitudes	3.80	Highly Feasible
9	Absence of conceptual errors	3.90	Highly Feasible
10	Representation of inclusive principles	3.85	Highly Feasible
	Overall Mean Score	**3.80**	**Highly Feasible**

The average score obtained from the content expert was 3.80**,** categorized as Highly Feasible. This indicates that the content of the H5P-based interactive video aligns with the objectives of the Inclusive Education subject, provides accurate concepts, and is suitable for deaf learners in higher education.

3.1.2 Media Expert Validation Results

The media expert evaluated the technical quality, visual design, interactivity, and usability of the H5P-based video within the Moodle LMS. The assessment consisted of 10 items using the same 4-point Likert scale. The results are shown in Table 4.

Table 4. Media Expert Validation Results

No	Aspect Evaluated	Mean Score	Category
1	Visual layout (color, text, and image balance)	3.80	Highly Feasible
2	Availability and clarity of captions or subtitles	3.60	Highly Feasible
3	Interactivity of H5P features	3.80	Highly Feasible
4	Ease of navigation in Moodle	3.70	Highly Feasible
5	Technical stability	3.70	Highly Feasible
6	Device compatibility	3.60	Highly Feasible
7	Readability of text and font size	3.70	Highly Feasible
8	Appropriateness of duration and pacing	3.65	Highly Feasible
9	Accessibility for deaf learners	3.75	Highly Feasible
10	Integration with learning activities	3.80	Highly Feasible
	Overall Mean Score	**3.71**	**Highly Feasible**

The mean validation score from the media expert was 3.71, categorized as Highly Feasible. The design, layout, and technical performance of the interactive video were considered well-structured and effective for implementation within Moodle LMS.

3.1.3 Effectiveness Test Results

The effectiveness of the developed H5P-based interactive video was measured using a one-group pre-test and post-test design involving three deaf students enrolled in the Inclusive Education subject. The data were analyzed using the normalized gain (N-Gain) formula by (Jacob & Centofanti, 2024):

$$N - Gain = \frac{\text{Spost} - \text{Spre}}{\text{Smaks} - \text{Spre}}$$

Table 5. Effectiveness Test Results

No	Student Code	Pre-test Score	Post-test Score	Maximum Score	N-Gain	Category
1	D1	50	85	100	0.70	High
2	D2	55	90	100	0.78	High
3	D3	52	88	100	0.69	High
Overall Mean Score		**52.3**	**87.7**		**0.72**	**High**

The average N-Gain value of 0.72 falls within the high improvement category. This indicates that the use of the H5P-based interactive video within the Moodle LMS effectively enhanced the students' understanding of the Inclusive Education subject materials.

The improvement in scores demonstrates that the interactive and accessible features of H5P were successful in maintaining focus and engagement among deaf students, thereby increasing comprehension.

Table 6. Overall Summary of Results

Aspect	Mean Score	Category	Conclusion
Content Expert Validation	3.80	Highly Feasible	Content is accurate and suitable for deaf learners
Media Expert Validation	3.71	Highly Feasible	Media is technically and pedagogically appropriate
Effectiveness (N-Gain)	0.72	High	Students' conceptual understanding improved

The developed H5P-based Interactive Video in the Moodle LMS is both feasible and effective as a learning medium to improve deaf students' understanding of Inclusive Education. It meets expert validation standards and demonstrates measurable improvement in learning outcomes.

Using a one-group pretest–posttest design, the effectiveness test results indicate that the use of H5P-based interactive video media in the Moodle Learning Management System enhances deaf students' understanding of Inclusive Education material, with an average N-Gain score of 0.72, categorized as high. Students' comprehension of Inclusive Education concepts improved from a pretest average score of 52.3 to 87.7 (N-Gain = 0.72), demonstrating a deeper understanding of diversity, equality, and participation principles.

Observations during implementation confirmed that students were able to navigate and utilize the H5P media effectively, although some initially required assistance in accessing interactive features and subtitles. These findings align with the Borg and Gall model, particularly in the implementation and evaluation phases, which emphasize iterative refinement based on user feedback. Furthermore, the results support the Universal Design for Learning (UDL) framework by highlighting the importance of providing multiple means of representation and engagement to support deaf learners' access to information. The constructivist learning perspective also underpins these findings, as the media fosters active learning through interaction and reflection.

However, it is important to acknowledge that the use of a one-group pretest–posttest design without a control group limits the ability to attribute learning improvements solely to the intervention. Therefore, the findings should be interpreted as indicative of potential effectiveness rather than definitive causal impact.

3.2 Discussion

The improvement in learning outcomes indicates that the interactive video provided structured and multimodal access to instructional content, which is essential for deaf students who rely heavily on visual learning modalities. It suggests that accessibility-oriented design features such as visual redundancy, synchronized information, and clear navigation supported students' comprehension of abstract concepts in Inclusive Education (Butler, 2019). The inclusion of sign language videos, subtitles, structured visuals, and step-by-step learning sequences enabled students to process and retain information more effectively.

From a Universal Design for Learning (UDL) perspective, these findings illustrate how providing multiple means of representation can enhance access to instructional content for deaf learners. The validation results from both material and media experts further reinforce this alignment. It indicate that the product achieved a high level of feasibility in terms of content clarity, visual layout, accessibility, and interactivity (Birinci & Sariçoban, 2021). In particular, aspects such as visual balance and integration with learning activities received the highest ratings, highlighting the importance of structured visual delivery for learners who depend on visual input (Azizah, 2020).

The interactive features embedded within the H5P videos, including quizzes, drag-and-drop tasks, and branching scenarios, encouraged active engagement rather than passive viewing. This aligns with constructivist learning principles, which emphasize that learners build knowledge through interaction and reflection (Kaba & Ellala, 2020). The ability to pause, replay, and revisit content allowed students to learn at their own pace, promoting autonomy and facilitating deeper conceptual understanding. Immediate feedback through embedded quizzes also supported formative assessment processes and enabled learners to monitor their progress continuously (Espada-Chavarria, González-Montesino, López-Bastías, & Díaz-Vega, 2023).

The effectiveness of the developed media also reflects the integration of technology, pedagogy, and content knowledge as conceptualized in the TPACK framework. The H5P-based videos were not merely technological enhancements but pedagogically aligned tools designed to present complex concepts such as inclusion, diversity, and equality in accessible formats (Alzahrani, 2022). The use of Moodle as a hosting platform further supported flexible and self-paced learning, allowing students to revisit materials as needed, which is particularly beneficial for deaf learners who may require repeated exposure to grasp detailed concepts.

These findings confirm previous research indicating that interactive multimedia can enhance engagement and comprehension among deaf learners through visual structure and learner interaction. At the same time, this study extends existing literature by demonstrating the feasibility of integrating accessibility-oriented interactive video within an LMS environment in higher education. Unlike many prior studies conducted at school levels or using standalone multimedia tools, this research highlights the potential of LMS-integrated solutions to support deaf students in concept-based subjects such as Inclusive Education (Ibrahim, Alias, & Nordin, 2016).

Qualitative reflections from students further support these findings, suggesting increased confidence and motivation when engaging with the video materials. The flexibility to control pacing and revisit explanations appeared to support understanding, particularly in situations where information might otherwise be missed in real-time instruction (Almeqdad, Alodat, Alquraan, Mohaidat, & Al-Makhzoomy, 2023). This underscores the value of learner-centered design that accommodates different processing speeds (Díez Villoria & Sánchez Fuentes, 2015).

Nevertheless, several methodological limitations must be acknowledged. The study employed a one-group pretest–posttest design without a control group, which limits the ability to attribute learning improvements solely to the intervention. In addition, the small sample size restricts the generalizability of the findings. Therefore, the results should be interpreted as indicative of potential effectiveness within a specific instructional context rather than as broadly applicable outcomes.

While the developed media demonstrated promising effectiveness, further enhancement is possible through the inclusion of additional features such as gamified elements, adaptive assessments, or contextual learning scenarios. Future research involving larger and more diverse samples, comparative designs, and longer-term observation is needed to validate and extend these findings.

Overall, this study suggests that H5P-based interactive video integrated within Moodle can support deaf students' understanding when designed according to UDL principles and supported by constructivist and TPACK-informed approaches (Riza, Firdaus, Junaeti, Bayu, et al., 2018). However, the effectiveness observed in this study may vary depending on course context, learner characteristics, and implementation conditions. These findings contribute to ongoing discussions on inclusive digital learning by illustrating how accessibility-oriented instructional design can support meaningful participation in higher education settings.

The findings also highlight the importance of instructional sequencing in supporting conceptual understanding among deaf students. The structured progression of content within the interactive videos appeared to help learners connect prior knowledge with new information, particularly when dealing with abstract themes such as inclusion and participation (Zamakhsyari, Wibowo, & Milad, 2022). This suggests that accessibility is not only about providing visual support, but also about organizing information in ways that align with learners' cognitive processing patterns.

Another important aspect emerging from this study is the role of learner control in reducing cognitive overload. The opportunity to navigate content non-linearly, repeat segments, and engage

with interactive checkpoints may have contributed to a more manageable learning experience. For deaf students who often rely on simultaneous visual inputs, the ability to regulate information flow is essential in preventing fragmentation of understanding (Buliali, Andriyani, & Pramudya, 2022).

Furthermore, the integration of interactive video within an LMS environment demonstrates the potential for technology to mediate learning beyond traditional classroom constraints. The asynchronous nature of Moodle-based access allowed students to revisit materials outside scheduled sessions, reinforcing continuity in learning. This flexibility may be particularly beneficial in higher education contexts where instructional time is limited and conceptual depth is required.

The study also underscores the importance of designing digital learning environments that support independence. By enabling students to interact directly with content without constant mediation from instructors or interpreters, the media promoted a more autonomous learning experience. Such autonomy is closely linked to the development of self-regulated learning behaviors, which are critical for academic success in inclusive higher education settings.

In a broader sense, the results contribute to the ongoing shift toward inclusive digital pedagogy in higher education. Rather than positioning accessibility as an add-on, this study demonstrates how accessibility-oriented design can be embedded into core instructional strategies. This approach not only benefits deaf students but also promotes a more flexible and responsive learning ecosystem for diverse learners.

4. CONCLUSION

This study developed and evaluated an H5P-based interactive video integrated into the Moodle Learning Management System to support deaf students in learning Inclusive Education. Expert validation indicated that the media achieved a high level of feasibility in terms of content quality (3.80) and media design (3.71). The implementation also resulted in a high learning improvement (N-Gain = 0.72), suggesting that the interactive video effectively enhanced students' conceptual understanding. The findings demonstrate that accessibility-oriented instructional design, supported by H5P interactive features and Moodle integration can facilitate meaningful participation and independent learning for deaf students in higher education. The study contributes practical evidence for implementing Universal Design for Learning (UDL) and technology-supported inclusive pedagogy in digital learning environments.

This study is limited by its small sample size and one-group implementation design. Future studies should involve larger participant groups, comparative research designs, and longitudinal evaluation to further examine the effectiveness and scalability of H5P-based interactive learning media in inclusive higher education.

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