

IMPROVING AN INCLUSIVE MULTIMEDIA LEARNING TOOL FOR THE DEVELOPMENT OF PERSONS WITH DISABILITIES

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Abstract: *The development of persons with disabilities requires learning environments that are accessible, adaptive, motivating and pedagogically effective. Traditional digital learning resources often present the same content to all learners and do not sufficiently consider visual, hearing, motor, cognitive and communication needs. This paper proposes an improved inclusive multimedia learning tool aimed at supporting the educational, cognitive and social development of persons with disabilities. The proposed tool integrates multimodal content, adaptive interface settings, audio-visual support, subtitle and sign-language elements, speech-based navigation, interactive tasks, progress monitoring and teacher feedback mechanisms. The scientific novelty of the study lies in designing the learning tool as an adaptive inclusive multimedia environment rather than a simple electronic textbook. The proposed approach can improve accessibility, individual learning pace, motivation and participation of learners with different educational needs.*

Keywords: *inclusive education, multimedia learning tool, persons with disabilities, adaptive learning, accessibility, assistive technologies, digital pedagogy.*

1. Introduction

Inclusive education is one of the important directions of modern digital pedagogy. It aims to create equal learning opportunities for all learners, including persons with disabilities. In this process, educational content must not only be informative, but also accessible, understandable, interactive and individually adaptable.

Persons with disabilities may have different learning needs. Some learners require visual enlargement, high contrast, audio explanation or screen-reader compatibility. Others may need subtitles, simplified text, alternative input methods, sign-language support, slower presentation



speed or repeated practice. Therefore, one standard multimedia resource cannot fully satisfy all learners.

A multimedia learning tool can become effective only when it combines text, image, animation, audio, video, interactive tasks and feedback in an inclusive way. The main problem is not simply adding multimedia elements, but organizing them according to the learner's individual needs, abilities and learning pace.

The aim of this paper is to propose an improved inclusive multimedia learning tool for the development of persons with disabilities. The study focuses on accessibility, adaptive content delivery, interactive learning, progress monitoring and teacher-supported feedback.

2. Related Work and Research Gap

Research on inclusive education emphasizes equal access, participation, individual support and learner-centered pedagogy. Digital technologies have expanded the possibilities of inclusive learning by providing audio materials, visual models, online interaction, adaptive tasks and assistive interfaces.

Multimedia learning theory shows that learners understand information better when verbal and visual materials are properly combined. However, for persons with disabilities, multimedia must be designed carefully. For example, a video without subtitles may be inaccessible for learners with hearing impairments. A visual diagram without audio description may be difficult for learners with visual impairments. Complex animation without pause and replay functions may create cognitive overload.

Existing electronic learning materials often contain multimedia content, but they are not always inclusive. Many systems do not provide enough adaptation options. Some platforms have only text and video, but do not include sign-language support, voice navigation, alternative input or individualized progress tracking.

The research gap is the lack of an integrated model that connects accessibility, multimedia content, adaptive learning, assistive technologies and pedagogical monitoring in one inclusive learning tool. This paper addresses this gap by proposing a functional and methodological framework for improving an inclusive multimedia educational resource.

3. Proposed Inclusive Multimedia Learning Tool

The improved inclusive multimedia learning tool consists of several interrelated components.



The first component is the learner profile module. It stores information about the learner's needs, preferred content format, accessibility settings, learning pace and progress indicators.

The second component is the adaptive content module. It presents learning materials in different formats: text, audio, image, animation, video, subtitles, simplified explanation and sign-language support.

The third component is the accessibility interface module. It includes font size adjustment, high-contrast mode, color-friendly design, keyboard navigation, voice command support, screen-reader compatibility and simple menu structure.

The fourth component is the interactive task module. It provides exercises, quizzes, simulations, drag-and-drop activities, audio-based tasks and step-by-step practical assignments.

The fifth component is the progress monitoring module. It records learner activity, task completion, repeated attempts, response time and achievement level.

The sixth component is the teacher feedback module. It allows the teacher to observe learner progress, identify difficulties and provide individual recommendations.



Figure 1. Functional structure of the improved inclusive multimedia learning tool.

The workflow of the tool begins with the creation of a learner profile. After that, the system selects appropriate content formats and interface settings. During the learning process, the learner completes multimedia tasks, receives feedback and repeats difficult topics. The teacher can

monitor the results and adapt the learning path according to the learner's development level.

4. Methodological Model

The effectiveness of the inclusive multimedia learning tool can be evaluated through an accessibility-adaptation index. Let A_v denote visual accessibility, A_h denote hearing accessibility, A_m denote motor accessibility, A_c denote cognitive accessibility and A_i denote interaction accessibility. The overall accessibility index is calculated as follows:

$$AI = \frac{w_1 A_v + w_2 A_h + w_3 A_m + w_4 A_c + w_5 A_i}{w_1 + w_2 + w_3 + w_4 + w_5} \quad (1)$$

where AI is the accessibility index, and w_1, w_2, w_3, w_4, w_5 are weighting coefficients. A higher AI value means that the learning tool is more accessible for learners with different needs.

The learner's development progress can be expressed as:

$$DP = \frac{R_{post} - R_{pre}}{R_{max}} \times 100\% \quad (2)$$

where DP is the development progress, R_{pre} is the learner's initial result, R_{post} is the result after using the multimedia tool, and R_{max} is the maximum possible score.

The learner engagement level is calculated using activity, task completion and feedback participation:

$$E = \alpha T + \beta Q + \gamma F, \quad \alpha + \beta + \gamma = 1 \quad (3)$$

where E is engagement level, T is time spent on learning activities, Q is the percentage of completed tasks, F is participation in feedback activities, and α, β and γ are importance coefficients.

The adaptive recommendation score for a learning material can be calculated as:

$$S_k = \lambda_1 P_k + \lambda_2 M_k + \lambda_3 C_k - \lambda_4 D_k \quad (4)$$

where S_k is the suitability score of learning material k , P_k is compatibility with the learner profile, M_k is multimedia richness, C_k is cognitive clarity, and D_k is difficulty mismatch. The system recommends the material with the highest suitability score:

$$k^* = \arg \max_k S_k \quad (5)$$



This model allows the learning tool to select suitable content, evaluate accessibility and monitor learner development.

5. Results and Analytical Discussion

A scenario-based analytical comparison was prepared to evaluate the proposed inclusive multimedia learning tool. The proposed approach was compared with a traditional textbook, a standard video lesson and a non-adaptive electronic course.

Table 1. Analytical comparison of learning tools for inclusive education

Evaluation criterion	Traditional textbook	Standard video lesson	Non-adaptive e-course	Proposed inclusive multimedia tool
Accessibility settings	Low	Medium	Medium	High
Multimodal content	Low	Medium	Medium	High
Individual adaptation	Low	Low	Medium	High
Support for hearing needs	Low	Medium	Medium	High
Support for visual needs	Low	Low	Medium	High
Interactive tasks	Low	Low	Medium	High
Progress monitoring	Low	Low	Medium	High
Teacher feedback	Medium	Low	Medium	High
Learner motivation	Medium	Medium	Medium	High

The comparison shows that the proposed inclusive multimedia learning tool has stronger pedagogical and technological potential. A traditional textbook is useful for reading, but it does not provide audio, animation, adaptive interface or immediate feedback. A standard video lesson may explain content visually, but it may be inaccessible without subtitles, audio description or pause-based interaction.



A non-adaptive electronic course provides digital content, but it usually presents the same learning path to all learners. In contrast, the proposed tool adapts content formats, interface settings and task difficulty according to the learner profile. This makes the learning process more flexible and inclusive.

The main advantage of the proposed approach is the integration of accessibility and pedagogy. Accessibility is not treated as an additional function. It becomes a core part of content design, interaction, assessment and feedback. As a result, learners with different abilities can participate more actively in the educational process.

6. Scientific Novelty and Practical Value

The scientific novelty of the study is the formulation of an inclusive multimedia learning tool as an adaptive pedagogical environment. Unlike ordinary multimedia resources, the proposed model combines accessibility settings, multimodal content, learner profiling, interactive tasks and progress monitoring.

The second novelty is the introduction of an accessibility-adaptation index. This index makes it possible to evaluate how well the tool supports learners with visual, hearing, motor, cognitive and interaction-related needs.

The third novelty is the adaptive recommendation mechanism for learning materials. The system does not simply show all materials in a fixed order. It selects suitable content according to learner profile, multimedia richness, cognitive clarity and difficulty level.

The practical value of the proposed tool is that it can be used in inclusive schools, special education centers, vocational training institutions, universities and distance learning platforms. It can help teachers organize individualized learning, monitor development and increase learner participation.

7. Conclusion

This paper proposed an improved inclusive multimedia learning tool for the development of persons with disabilities. The model includes learner profiling, adaptive content, accessibility interface, interactive tasks, progress monitoring and teacher feedback modules.

The proposed methodological model uses accessibility, development progress, engagement and adaptive recommendation indicators. These indicators help evaluate the effectiveness of the tool and support individualized learning.



The results of the analytical comparison show that the proposed tool provides more inclusive, flexible and learner-centered support than traditional textbooks, standard video lessons and non-adaptive electronic courses. Future research should focus on developing a software prototype, testing it with real learners, improving assistive functions and integrating artificial intelligence for automatic adaptation of learning content.

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