sustainability

MDPI

Article

Sustainable Technology-Enhanced Learning for Learners with Dyslexia

Donatas Iliska * and Daina Gudoniene

Faculty of Informatics, Kaunas University of Technology, Studentu Str. 50, LT-44249 Kaunas, Lithuania; daina.gudoniene@ktu.lt
* Correspondence: donatas.iliska@ktu.edu

Abstract: Sustainable and technology-enhanced learning (TEL) plays a crucial role in supporting learners with dyslexia by providing accessible, personalized, and inclusive educational experiences. The case study discusses learning challenges of students with dyslexia due to both pedagogical and technological factors. Traditional teaching methods that rely heavily on text-based instruction can make it difficult for them to process and retain information. Many digital tools and learning platforms are not designed with accessibility features like text-to-speech or dyslexia-friendly fonts, making it harder for dyslexic students to engage with content. A lack of individualized instructional approaches, such as multisensory learning or adaptive learning technologies, can hinder their progress. Additionally, inadequate teacher training on dyslexia-friendly strategies can result in ineffective support in the classroom. The aim of this paper is to identify the most appropriate pedagogical and technological aspects and their applicability to the development of tools for dyslexic learners and to elucidate the most effective way of learning according to needs. This paper presents a case study on the learning object design to overcome dyslexia barriers and improve the quality of students' learning.

Keywords: dyslexia; inclusive education; pedagogical models; accessibility; learning objects

check for updates

Academic Editors: Gwo-Haur Hwang, Hsi-Hsun Yang and Hsin-Yi Liang

Received: 24 March 2025
Revised: 30 April 2025
Accepted: 12 May 2025
Published: 15 May 2025

Citation: Iliska, D.; Gudoniene, D. Sustainable Technology-Enhanced Learning for Learners with Dyslexia. *Sustainability* **2025**, *17*, 4513. https://doi.org/10.3390/su17104513

1. Introduction

Dyslexia is one of the most common learning difficulties affecting students worldwide, influencing their academic performance and emotional well-being. It is widely acknowledged as a specific learning disorder that primarily impacts literacy acquisition, including reading, writing, and spelling skills. Students with dyslexia often face challenges not only in mastering basic literacy but also in maintaining motivation and self-confidence throughout their educational journey.

The growing integration of digital technologies into education presents both opportunities and challenges for learners with special needs. Assistive technologies and inclusive design approaches offer new ways to bridge educational gaps and support diverse learners, including those with dyslexia. However, many mainstream digital learning tools are not fully adapted to the needs of students facing cognitive barriers, risking an increased learning divide.

In Lithuania, where this study was conducted, awareness about the importance of inclusive education is gradually increasing. Nevertheless, the practical implementation of adaptive digital learning environments remains inconsistent and underdeveloped.

This study aims to identify which functionalities in digital learning objects are considered essential by professionals who work with students with dyslexia in order to inform the design of more inclusive digital learning tools. Based on these findings, a prototype has been developed; however, the prototype itself is not evaluated within the scope of this paper.

The remainder of this paper is structured as follows:

Section 2 describes the theoretical background, including causes and challenges related to dyslexia, as well as design models and digital tools relevant for inclusive learning.
Section 3 outlines the research methodology, including the study design, sample, instruments, and data collection procedures.
Section 4 presents the results of the empirical investigation, including key findings from the survey conducted with educational professionals.
Section 5 introduces a new approach to designing educational tools for students with dyslexia based on the findings of this study and including a model for the design of learning objects.
Section 6 provides the discussion, interpreting the results in relation to relevant theories and findings from the field of technology-enhanced learning (TEL).
Section 7 outlines the limitations of this study, addressing constraints related to sample size, generalizability, and methodology.
Finally, Section 8 presents the conclusions and implications for practice, offering insights for future research and recommendations for the design of inclusive digital learning objects for students with dyslexia.

2. Theoretical Background

2.1. Understanding Dyslexia: Causes, Difficulties, and Types

Dyslexia is a neurodevelopmental disorder that affects the ability to accurately and fluently decode words, despite having normal intelligence and adequate educational opportunities [1]. It is primarily caused by deficits in phonological processing, which interfere with recognizing sounds in spoken language and connecting them to written letters [1].

Neurobiological studies have shown that dyslexia is linked to structural and functional differences in the brain regions responsible for language processing, including the left temporoparietal cortex [2–4]. These anomalies can result in significant reading and writing difficulties, especially in early school years when learners are expected to acquire basic literacy skills. Children with dyslexia may confuse letters, have trouble matching letters to sounds, or read slowly and inaccurately, which can negatively impact their academic performance and self-esteem.

Depending on the underlying cognitive impairments, dyslexia can be classified into several types: agrammatic, phonemic, mnemonic, optical, tactile, and semantic (Figure 1) [5–8]. This complexity highlights the importance of targeted support and teaching strategies tailored to the specific type and needs of the learner.

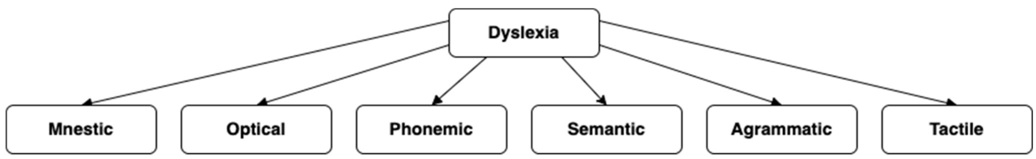

Figure 1. Classification of dyslexia.

2.2. Educational Support for Dyslexic Learners in Lithuania

In Lithuania, children with dyslexia face specific challenges in accessing appropriate educational support. Although dyslexia is recognized by educational experts, the term itself is not formally included in the national list of special educational needs. This lack of formal recognition complicates the clear identification of learning difficulties and delays the provision of adequate support tailored to learners' individual needs [9].

To address reading-related challenges, the Ministry of Education, Science and Sport of the Republic of Lithuania has introduced a procedure that classifies reading disabilities as a specific learning disability [10]. This provides a legal basis for supporting children with dyslexia, yet in practice, they are often placed in broad categories that fail to reflect their unique difficulties.

Support services for dyslexic students in Lithuania are available both in mainstream and specialized educational settings, primarily through the work of special educators and speech and language therapists. However, the implementation of these services remains inconsistent. While the framework exists, actual interventions are often minimal and not sufficiently personalized [10].

Experts stress the importance of multidisciplinary assessment teams—including psychologists, speech and language therapists, and special educators—to ensure appropriate diagnosis and intervention [9]. Despite this, many educators report lacking the practical tools, targeted strategies, and professional training necessary to support dyslexic learners effectively [11]. As a result, there is a clear need for more coherent and systematic approaches that can help learners with dyslexia participate more fully in the learning process and achieve better educational outcomes.

Despite the existence of a theoretical support system in Lithuania, distance learning presents additional challenges for dyslexic students. Difficulties with reading and writing make it harder for them to study independently and interact with digital learning platforms. Research indicates that certain technological tools—such as audiobooks, text-to-speech software, and writing support applications—can improve learning outcomes by helping students overcome decoding difficulties and better retain information [12]. However, in Lithuania, the availability of such tools remains limited, and many educators lack the training to integrate them effectively into everyday teaching practices. This is especially evident in distance education, where the lack of appropriate tools and strategies directly affects students' learning success. To provide more effective support for dyslexic learners, it is essential to ensure access to tailored teaching resources and specialist services that respond to each learner's individual needs. Studies also highlight that the most effective approaches involve training in phonological awareness, multimodal teaching methods using multiple sensory channels (e.g., visual, auditory, tactile), and the integration of digital learning tools, including speech synthesizers [13]. The 2022 recommendations from the Ministry of Education, Science and Sport reinforce the importance of personalized learning, encouraging curriculum adaptation based on individual student abilities and challenges. Properly adapted tools and professional support not only facilitate learning but also contribute to increased motivation and self-confidence among dyslexic learners.

2.3. Learning and Teaching Challenges

Designing effective learning objects for students with dyslexia presents a significant educational challenge, as it requires careful alignment of content and methods with the learners' individual abilities and needs [14]. However, creating and designing such materials involves multiple barriers that must be addressed to ensure both accessibility and pedagogical effectiveness. Dyslexia affects key areas such as reading, writing, and comprehension, making it difficult for students to engage with traditional learning content. One major obstacle is the strong reliance on text-heavy resources, which can overwhelm dyslexic learners. Features such as long paragraphs, complex vocabulary, and inappropriate font choices further hinder the reading process. Moreover, students with dyslexia often struggle with working memory and information retention, which can lead to cognitive overload if learning objects are not properly scaffolded and paced [14].

Another important challenge is the lack of multisensory integration in many digital learning tools. Learners with dyslexia benefit from approaches that combine visual, auditory, and tactile modalities, yet many materials fail to include such options. The absence of tools like text-to-speech, speech-to-text, and interactive visual aids can limit student engagement. Additionally, traditional standardized assessments often do not accommodate dyslexic learners, and learning objects that lack adaptive feedback mechanisms may fail to accurately reflect students' progress or support improvement [15].

Accessibility and usability also remain major concerns. Many educational materials are not developed according to inclusive design principles such as the Universal Design for Learning (UDL), resulting in difficult navigation, confusing interfaces, and a lack of personalization options. Ensuring adaptability to individual learning needs is essential for success. To address these challenges, learning design frameworks like the UDL are vital. By incorporating multiple means of representation, engagement, and expression, these models support more equitable learning environments and help dyslexic students access content in formats that suit their cognitive strengths [15].

2.4. Tools and Methods for Dyslexic Learners

The learning process for dyslexic learners requires specially adapted tools and methods to enable them to participate successfully in educational activities. While modern technology offers the possibility of creating interactive learning objects, it is essential that these objects meet not only best practice but also specific accessibility and functionality requirements (Figure 2) [13].

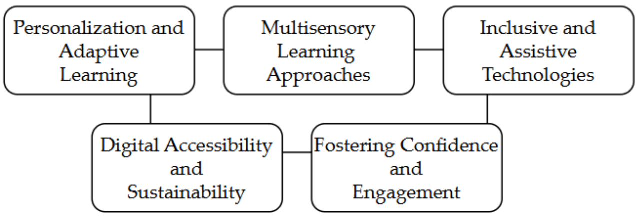

Figure 2. Technology-enhanced learning methods supporting learners with dyslexia.

Personalization and adaptive learning environments, which customize educational content and strategies to individual learners, offer a promising approach. Personalization within adaptive learning environments is crucial for addressing learner diversity and maximizing engagement and learning outcomes [14]. Moreover, technologies allow for personalized learning experiences tailored to the needs of learners with dyslexia. Artificial intelligence (AI)-powered platforms can adjust the pace of lessons, provide real-time feedback, and offer alternative instructional methods such as text-to-speech (TTS), speech-to-text (STT), and interactive learning modules. These tools help dyslexic learners grasp concepts more effectively without feeling overwhelmed.

The multisensory technique is an alternative used as reference material for tutors to help dyslexic students improve their reading skills. Multisensory techniques that can be used include (1) reading and spelling training, (2) visual techniques, (3) auditory techniques, and (4) tactile techniques. The reading and spelling focus on maintaining relationships between sounds and symbols starts with a single letter and continues with consonant combinations, vowel continuation, and complex letter groupings [15]. The visual technique can start by using a picture card with the word written on the bottom (flashcard). The auditory technique is used with children who have difficulty with sound problems, involving teaching the child a pair of short words and asking them to say which word is correct. In addition, children with dyslexia will have the best learning by touch, so it is essential to incorporate this learning style into the instruction as a tactile technique.

Inclusive and assistive technologies are related to technology-enhanced learning, which incorporates assistive technologies that support dyslexic learners in overcoming literacy challenges. Tools such as optical character recognition (OCR) software (https://ocr.space/), dyslexia-friendly fonts, and AI-driven reading assistants make digital and printed content more accessible [16]. These technologies ensure that learners with dyslexia can access and process information at their own pace, fostering independence in learning. Moreover, emerging technologies enabling personalized and adaptive learning include learning analytics, artificial intelligence, machine learning, intelligent tutors, adaptive controls, and robust interactive learning content.

Digital accessibility and sustainability ensure the integration of digital resources, while sustainable learning reduces the dependence on traditional textbooks, making education more environmentally friendly and cost-effective. Open educational resources (OERs) and cloud-based platforms provide continuous access to learning materials, ensuring that learners with dyslexia can revisit lessons as needed. This approach promotes lifelong learning and reduces educational inequalities [16,17].

Fostering confidence and engagement is related to technology-enhanced learning and can support an inclusive environment where dyslexic learners feel empowered rather than discouraged. Gamification, AI-driven tutors, and interactive learning applications help maintain motivation and engagement by turning challenges into rewarding experiences. The ability to customize learning paths and track progress builds confidence and self-esteem.

2.5. Instructional Design Models for Developing Digital Learning Objects

Various models influence the learning outcomes of learners with dyslexia by addressing cognitive, linguistic, and socio-emotional factors. We analyze very different models that are related to our targets. The phonological deficit model suggests that dyslexia arises from difficulties in processing phonemes, affecting reading and spelling skills. The rapid automatized naming model highlights challenges in retrieving verbal information quickly, impacting fluency. Another theory proposes that visual and auditory processing deficits contribute to reading challenges. The connectionist model emphasizes how neural networks process written language and the importance of structured, multisensory learning approaches. These models are crucial for understanding the diverse needs of learners with dyslexia and developing targeted interventions. We also focus on the learning design models that are directly related to successful learning outcomes.

The ADDIE model provides a structured way to design learning objects through analysis, design, development, implementation, and evaluation [18–21]. This method allows for continuous refinement based on feedback and learner needs.

Another effective model is the Successive Approximation Model (SAM), which promotes an iterative approach to design. By developing and testing learning objects in small phases, designers can adjust features based on user experience. The TPACK framework integrates technology, pedagogy, and content knowledge to create effective digital learning experiences, ensuring that learning objects are engaging and accessible [22]. By applying these models, educators and instructional designers can develop learning objects that are inclusive, supportive, and tailored to the needs of students with dyslexia. To identify the most appropriate model, we performed a comparative analysis of these models [18–21,23–29], shown in the table below (Table 1).

Table 1. Comparative analysis of learning design models.

Criterion	ADDIE	Dick and Carey	A.S.S.U.R.E	Pebble-in-the-Pond
Clear Structure	Clear, sequential, and methodical.	Well structured, effective for complex projects.	Clearly defined and easy to follow, yet less comprehensive than ADDIE.	Logical and problem-oriented, yet less detailed.
Feedback	Incorporated in evaluation but less intensive.	Embedded within formative assessment.	Robust, embedded in evaluation for continuous enhancement.	Integral, relying on iterative refinement.
Individualization	Limited, prioritizes structured processes over personalization.	Feasible but emphasizes systematic instruction.	Highly adaptable, requiring analysis of learner needs.	Highly adaptable, facilitating tailored learning tasks.
Interactivity	Present but secondary, focuses on content organization.	Moderate, prioritizes content analysis and task structuring.	Fundamental, promoting active learner engagement.	Significant, with learners actively engaged in problem solving.
Flexibility	Adaptable but constrained in iteration.	Moderate, formalized approach necessitating consistency.	Highly flexible, enabling rapid content modification.	Moderate, structurally rigid and occasionally difficult to modify.
Problem-Based Learning	Not central but may be incorporated.	Can be included but not a focal aspect.	Possible but not the principal focus.	Core feature, optimized for real-world scenario analysis.
Technology Integration	Not emphasized but may be integrated as required.	Feasible but not a predominant feature.	Explicitly emphasized, well suited to contemporary learning environments.	Appropriate but prioritizes task-driven rather than technological solutions.

The A.S.S.U.R.E model is well suited for creating learning objects for students with dyslexia because it emphasizes analyzing the target group's needs, which helps developers understand students' abilities and challenges [23,27]. While the model does not provide detailed guidelines for technology implementation, it encourages developers to adopt modern solutions. Compared to other models, such as ADDIE or Dick and Carey, which focus on systematic process management, A.S.S.U.R.E stands out for its flexibility and emphasis on personalized learning [23,28]. The A.S.S.U.R.E model allows developers to flexibly tailor content to meet individual learning needs, unlike the Pebble-in-the-Pond model, which emphasizes problem-based learning but lacks sufficient adaptation for dyslexic students [25–29].

2.6. Comparison of Authoring Tools for Creating Learning Objects

To ensure that the learning objectives are met when developing learning objects, it is imperative to select appropriately integrated content authoring tools. For the purpose of the analysis (Table 2), the most popular proprietary and free learning content authoring tools were selected, and they were evaluated according to the following criteria [30–34]:

- Interactivity. What capabilities exist for creating interactive content?
- Support and Interface. Is there an intuitive user interface and are there tools available to provide effective support for students with dyslexia?
- Functionality. Is there the possibility of installing developed plug-ins and extending the functionality of the tool?
- Sharing. What opportunities are available to host the created learning objects on various LMS platforms?

Table 2. Comparison of learning object authoring tools.

Tool	Interactivity	Support and Interface	Features	Sharing
eXeLearning	High level (tests, HTML, CSS, interactivity)	Excellent support—font size, color adjustments	Supports HTML, JavaScript, CSS, additional content	Exports to HTML, SCORM, AICC
Adobe Captivate	Advanced level (VR, interactive content)	Extensive functionality and an excellent interface	Supports HTML5, VR integration, quizzes	Exports to SCORM, xAPI, AICC
CourseLab	Medium level, templates, tests	Limited—no special features for dyslexia	Ability to integrate HTML, JavaScript	Supports SCORM, easily exports courses
Reload	Does not support interactive content creation	Limited—no integrated support	Can edit SCORM XML files	Creates and validates SCORM packages
H5P	High level (games, tests)	Good support—fonts, color customization	Additional plugins integrated into LMS	Integrates with Moodle, WordPress
Xerte	Medium level interactivity	Some features available (e.g., font size)	Can integrate and customize code	Exports to SCORM and other formats
Lectora	High level (many features)	Good capabilities—including accessibility	Supports multiple export formats	Exports to HTML, SCORM, AICC
iSpring Suite	High level (integration with PowerPoint)	Intuitive and easy to use	Includes various multimedia features	Exports to SCORM, xAPI, MP4
Articulate Storyline	High level (compatible with interactivity)	Modern and user-friendly	Supports HTML5, mobile-friendly interface	SCORM, xAPI, AICC

Following a literature review [30–34] and a comparative analysis based on the aforementioned aspects, it has been determined that the most effective tools for developing learning content are eXeLearning and Adobe Captivate. These tools successfully integrate technological capabilities with the requirements of individualized teaching solutions. eXeLearning, an open-source tool, facilitates content creation through the use of HTML, JavaScript, and CSS. This approach ensures flexibility in adjusting color contrasts, font sizes, and other essential interactive features, thereby catering to the needs of students who require additional support.

It should be noted that, according to the study conducted by Tentama et al. [31,32], eXeLearning is particularly well suited for developing learning objects in the field of sciences. By contrast, Adobe Captivate, although a commercial proprietary tool, distinguishes itself through a more advanced range of features, including interactive simulations, multimedia integration, and even the capacity to implement virtual reality elements. These functionalities not only enable students to participate more actively but also foster the development of practical competences through an inclusive learning experience. Although eXeLearning and Adobe Captivate differ in terms of functionality, both are valuable tools that offer greater opportunities than many other proprietary solutions. The eXeLearning tool is especially advantageous for projects with constrained budgets, whereas Adobe Captivate is designed for the creation of more complex and costly projects. In our study, both of these tools will be employed, and the learning objects created using them will be evaluated with the target group [19].

We focus on the open tools like eXeLearning which is a free, open-source software designed for the creation of interactive educational content. This tool was developed in 2007 in New Zealand in collaboration with the University of Auckland, Auckland University of Technology, and the Tai Rawhiti Polytechnic Institute, with funding from the New Zealand government. Since 2010, the project has been further developed by Spanish governmental agencies and other organisations [31,35].

Adobe Captivate is another widely used authoring tool designed for the development of complex and interactive learning materials, with the ability to integrate virtual reality elements [36,37]. Initially developed as RoboDemo (originally known as Flashcam) by the company eHelp Corporation, it was acquired by Macromedia in 2004 and subsequently by Adobe shortly thereafter. The following key functionalities can be identified.

Developing a learning object tailored to students with dyslexia necessitates a systematic approach to instructional design. The initial step involves selecting an appropriate method encompassing pedagogical content creation strategies while addressing the specific needs of learners with special educational requirements. As discussed in the previous section, the A.S.S.U.R.E. model has been chosen for this purpose, as it incorporates elements specifically aimed at designing learning content for students with diverse learning needs. The process begins with assessing the need for an adapted learning object, then analyzing learners' needs and considering the most suitable design frameworks. The A.S.S.U.R.E. model's relevance and applicability to the specific educational context are evaluated upon selection. Subsequently, learner characteristics are examined, learning objectives are clearly defined, and the most appropriate instructional methods and materials are identified. Particular emphasis is placed on content interactivity and the provision of learner support mechanisms. The next phase aims to ensure that interactive elements enhance learner engagement, fostering active participation in the learning process. Finally, a comprehensive evaluation is conducted to determine the extent to which the established criteria for learning object effectiveness have been met. This evaluation includes accessibility considerations, the achievement of learning outcomes, and the overall usability of the learning interface.

2.7. Applying WCAG Principles to Inclusive Learning Object Development

Once an appropriate model for learning object design has been selected, it is essential to ensure that the developed tool—in this case, a learning object—adheres not only to best practices but also to international standards, such as the web content accessibility guidelines (WCAGs). These standards are highly relevant and should be taken into consideration, as they provide a framework that ensures digital content is accessible to all users, including individuals with visual, auditory, physical, speech, cognitive, and neurological impairments [14,38]. Additionally, these standards enhance accessibility for users who rely on assistive technologies, such as screen readers or text-to-speech software.

The WCAG framework is based on four fundamental accessibility principles which outline guidelines for designing content that is both accessible and functional for all users: (1) perceivable; (2) operable; (3) understandable; and (4) robust.

The principle of perceivability ensures that content is easily perceivable by all users. This means that text should be legible with adequate contrast, while visual and auditory materials should be supplemented with descriptions and subtitles.

The principle of operability guarantees that content can be navigated in multiple ways. Users must be able to interact with content using keyboard navigation, and sufficient time should be provided for interactive actions to be completed.

The principle of understandability requires that content is clearly comprehensible to users. Language should be simple and clear, avoiding unnecessary technical jargon or complex structures that may hinder comprehension.

Finally, the principle of robustness ensures that content is compatible with various platforms, browsers, and assistive technologies. This necessitates the correct and standardized coding structure, enabling seamless content delivery across different digital environments. By adhering to these principles, digital learning objects can be designed to maximize inclusivity and accessibility, thereby fostering an equitable learning experience for all users.

In summary, the application of WCAG standards ensures that learning objects are accessible to all users, including students with dyslexia. Standardized content not only meets legal and ethical requirements but also contributes to learner engagement, motivation, and the ability to achieve improved learning outcomes. Thus, the key conclusion is that a well-designed learning object that adheres to these standards becomes an effective tool for supporting the attainment of educational objectives for all students.

3. Methods

3.1. Methods, Design, and Settings

The purpose of this study was to explore which functionalities in digital learning objects are considered essential for supporting students with dyslexia based on the perspectives of educational and support specialists. The research followed a descriptive, exploratory design and was implemented using a case study approach, focusing on technological considerations in inclusive digital learning.

To guide the empirical part of the study, the following two hypotheses were formulated:

H1: *Certain functionalities in digital learning objects are considered more essential than others by professionals working with students with dyslexia.*

H2: *The functionalities considered most essential align with those recommended in the existing literature on dyslexia and inclusive learning.*

These hypotheses are grounded in both previous research and practical needs. Numerous studies emphasize the importance of accessibility features (e.g., adjustable text size, dyslexia-friendly fonts), multimodal learning approaches (e.g., text-to-speech, visual supports), and customizable interfaces as key elements for inclusive learning environments [12–17]. Thus, H2 reflects the expectation that practitioners' views would converge with scholarly recommendations. H1 stems from the assumption that professionals can distinguish between more and less important features based on their field experience.

3.2. Sample

The study sample consisted of 21 respondents, including special education teachers, educational support specialists, and school psychologists. All participants had experience working directly with students with dyslexia across various educational settings. The sampling was purposive, focusing on professionals familiar with inclusive education and digital learning tools. The questionnaire was distributed online through relevant professional groups and social media platforms related to special and inclusive education. Participation was voluntary and anonymous.

3.3. Ethical Considerations

This study was conducted in accordance with the ethical standards of the hosting institution and open science principles. The online questionnaire was distributed to a voluntary sample of educators, psychologists, and educational support specialists. Informed consent was obtained prior to participation. Participation was fully anonymous, no personal or biometric data were collected, and respondents were informed about the purpose and scope of the research. Therefore, according to national regulations, approval from a bioethics committee was not required.

3.4. Data Collection

The research data were collected through an online questionnaire distributed to educational and support specialists who work with students with dyslexia. The questionnaire was disseminated via professional networks and social media platforms focused on special education. Participation was fully voluntary and all responses were collected anonymously; no identifying information was requested from participants. The questionnaire consisted of both closed-ended and open-ended questions. Nineteen items were based on a 5-point Likert scale (from 1—not important to 5—very important), aimed at evaluating the perceived importance of various functionalities in digital learning objects. In addition, five open-ended questions allowed participants to provide more detailed insights, suggestions, and professional reflections. This mixed-question format enabled the collection of both quantitative data and qualitative feedback relevant to the development of inclusive learning tools. The questionnaire content was aligned with the research hypotheses, particularly regarding the expected importance of accessibility and personalization functionalities for dyslexic learners. The study followed a descriptive design, and the questionnaire was developed to support the research aim of identifying essential functionalities in learning objects for dyslexic students. The results informed the design of a prototype, as outlined in the subsequent sections.

3.5. Instruments Used

The theoretical framework was built to be related to the learning process (see Figure 3. Methodology for case implementation). It starts with the identification of relevant problems of students with dyslexia, discussing a theoretical body of knowledge and fuzzy info from many sources. The next step focuses on problem solving, looking for effective solutions for learners with dyslexia; then, practical relevance and theoretical relevance are presented, Finally, we evaluate the case and its usability effectiveness.

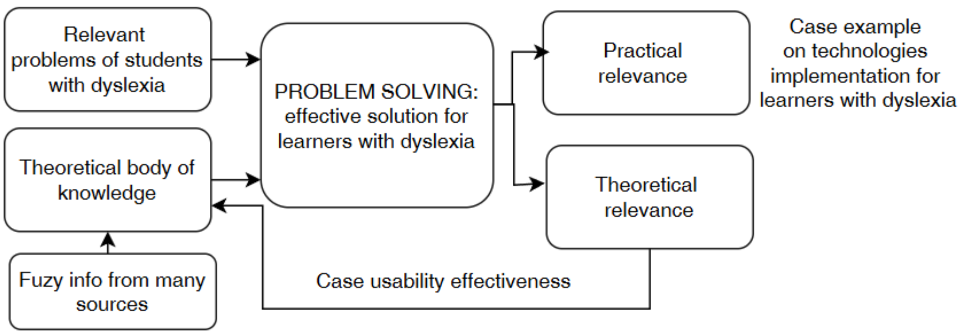

Figure 3. Methodology for case implementation.

Moreover, the case study is based on the reflections, feedback, and assessments of the module's teachers and the students.

3.6. Data Analysis

The collected data were analyzed using descriptive statistics. Frequencies, percentages, and mean scores were calculated to determine which functionalities were considered most important by the respondents. Open-ended responses were analyzed qualitatively through thematic categorization to identify recurring ideas and recommendations. Inferential statistical methods, such as *t*-tests or ANOVA, were not applied due to the small sample size (n = 21), the descriptive nature of the research, and the fact that no comparisons between subgroups were intended.

4. Results

The results indicate that content delivery and customization functions (Figure 4) were regarded as highly important by the respondents. In particular, the ability to adjust text size and font type was considered "essential" by the vast majority of participants. Furthermore, the options to customize background and text colors, to utilize text-to-speech (TTS) technology, and to minimize the amount of text displayed on screen were consistently valued. The step-by-step presentation of learning content was also highlighted as a crucial feature to enhance comprehension and engagement among learners with dyslexia.

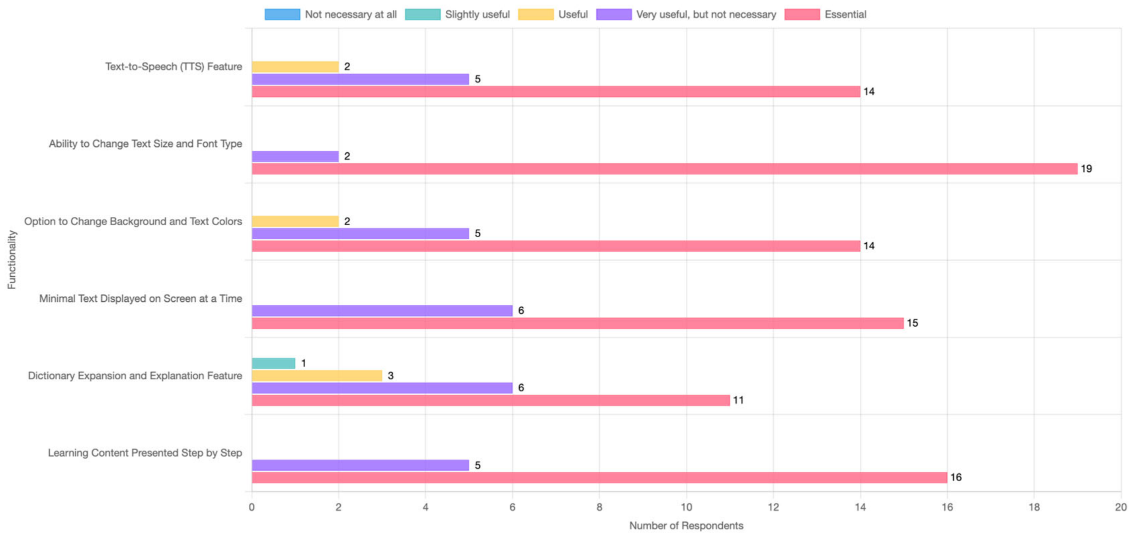

Figure 4. Content delivery and customization functions.

These findings underscore the crucial importance of flexible and personalized content presentation in fostering inclusive learning environments. The emphasis on adjustable visual and auditory elements highlights a pressing need to accommodate diverse perceptual and cognitive profiles. By enabling learners to exercise greater control over how information is presented and accessed, educational platforms may substantially reduce cognitive overload, enhance motivation, and promote a sense of autonomy among students with dyslexia. Consequently, the integration of content customization tools ought to be regarded as a fundamental principle in the design of digital learning objects for inclusive education.

A variety of perspectives emerged regarding the importance of learning management features (Figure 5). Functions such as the provision of reminders, the use of hint systems, and the implementation of automatic attention management were generally perceived positively. In contrast, the feature restricting the ability to complete multiple tasks concurrently elicited more divided opinions among respondents. Elements that provided structured guidance, including the description of learning steps and the automatic highlighting of text, were consistently identified as essential by the majority of participants.

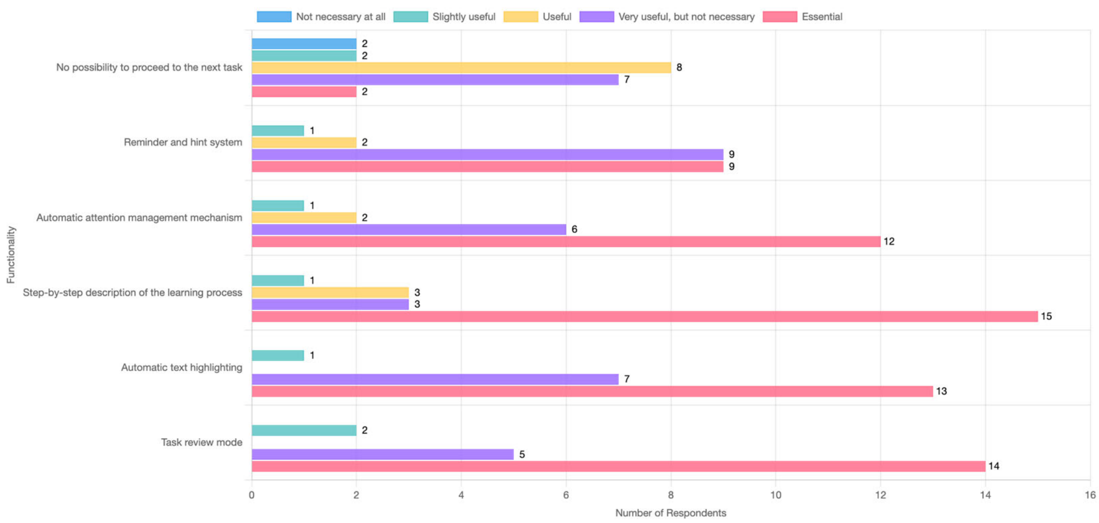

Figure 5. Management of the learning process.

These patterns suggest that, although there is limited consensus regarding workflow control mechanisms, there is strong agreement on the importance of supportive features that clarify learning progression. Structured instructional cues and visual prompts appear to be integral for sustaining learner focus, enhancing task comprehension, and facilitating independent navigation through educational content. Embedding such supportive mechanisms within digital learning objects may therefore be considered fundamental to promoting accessibility and academic success among students with dyslexia.

Feedback and personalization functions (Figure 6) were regarded as important components of the learning process. Respondents particularly emphasized the significance of progress monitoring tools, motivational features, and automatic speech correction as essential support for learners with dyslexia. The automatic feedback mechanism received more varied evaluations, with some participants considering it necessary and others viewing it as merely useful, although it remained a valued element overall. The integration of timely and personalized feedback appears critical for fostering learner engagement, promoting autonomy, and supporting skill acquisition within inclusive digital learning environments.

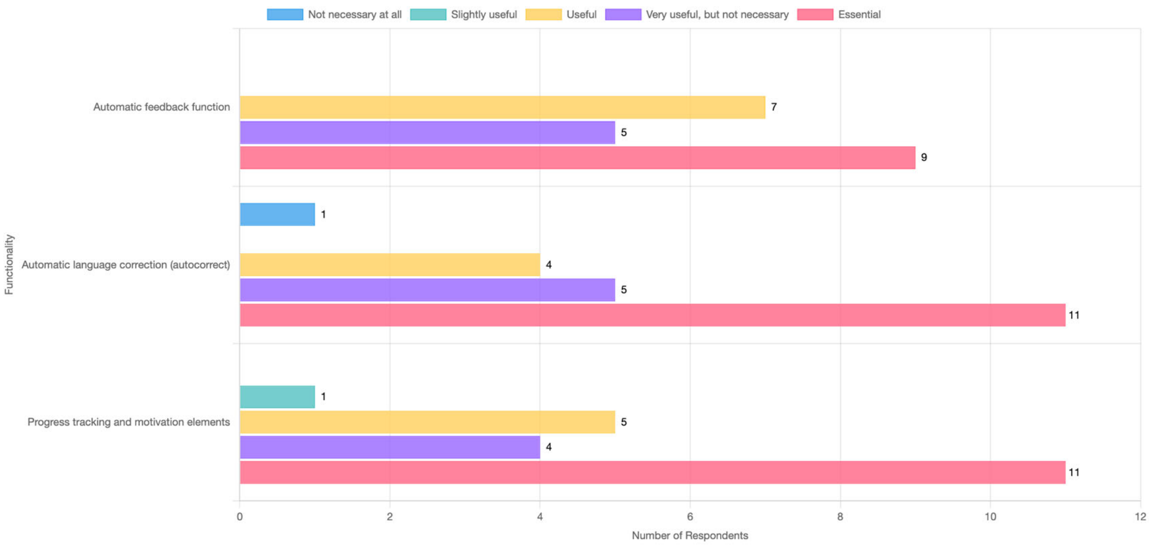

Figure 6. Feedback and personalization functions.

Interactivity and the provision of alternative methods were identified as essential elements within the learning process (Figure 7). Respondents placed particular value on the ability to dictate answers by voice, with the majority rating this feature as essential for supporting accessibility and reducing cognitive load. Tasks that did not require text input were similarly highly appreciated, receiving consistently positive evaluations for their contribution to facilitating engagement and accommodating diverse learner needs. Furthermore, interactive illustrations, pictures, and icons were regarded as important components for enhancing understanding and sustaining attention. Strong support for these features was observed across the participant group, highlighting the crucial role of visual and interactive elements in creating inclusive and motivating digital learning environments for students with dyslexia.

Interactive and multimodal approaches play a crucial role in enhancing engagement, motivation, and overall learning outcomes among students with dyslexia. Offering alternative methods of input, such as voice dictation, alongside rich visual representations through illustrations, icons, and interactive features, accommodates a wide range of learning preferences and cognitive profiles. These adaptations support greater accessibility, reduce cognitive barriers, and foster more active participation within digital learning environments. The incorporation of such features can therefore make a substantial contribution to the development of more inclusive, accessible, and effective educational experiences that better address the needs of diverse learners.

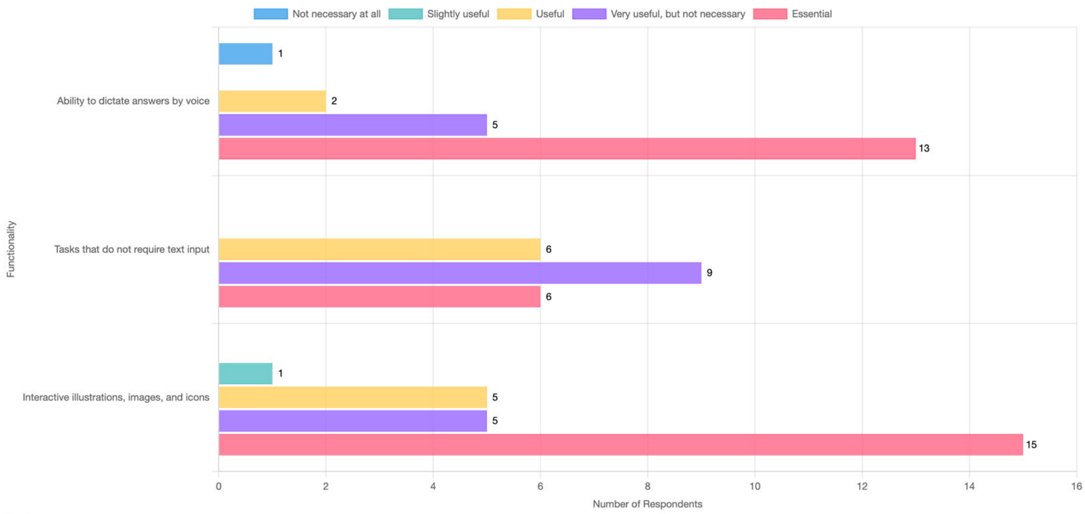

Figure 7. Interactivity functions.

Summary of Findings

Respondents evaluated 19 functionalities of digital learning objects using a 5-point Likert scale (1—not important; 5—very important). The highest-rated functionalities included the ability to change text size and font (M = 4.90), segmentation of content into smaller units (M = 4.76), and limiting the amount of text per screen (M = 4.71). Other features that received high importance ratings were the use of illustrations and icons (M = 4.62), text-to-speech options (M = 4.57), and the ability to customize background and text colors (M = 4.57). The full list of functionalities and their average ratings are visualized in Figure 8.

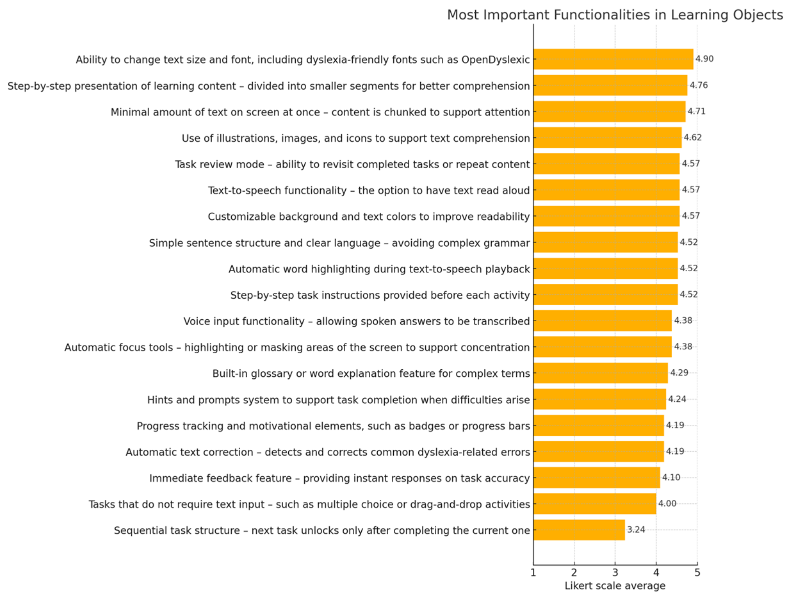

Figure 8. Average Likert ratings of key functionalities in learning objects according to specialists.

In addition to the closed-ended responses, participants provided qualitative feedback that offered deeper insight into their preferences. Several specialists emphasized the importance of multimodal support, including both audio and visual elements. Flexibility in how content is presented—such as adjustable layout, contrast, and reading modes—was noted as critical for improving accessibility. Respondents also suggested minimizing text input requirements and incorporating interactive elements like multiple-choice or drag-and-drop formats as alternatives to traditional tasks.

5. A New Approach to Designing Educational Tools for Dyslexic Students

5.1. A Model for the Design of Learning Objects for Students with Dyslexia

Based on both the literature review and the empirical findings of this study, we identified four essential categories of functionalities required for implementing effective learning objects for teaching learners with dyslexia: (1) accessibility, (2) interactivity, (3) feedback, and (4) technological compatibility for integration into various learning platforms. These categories reflect both theoretical recommendations and the perspectives of educational and support specialists who participated in the survey. Implementing learning objects with these functionalities is critical for enhancing the learning experience, increasing engagement, and reducing barriers for dyslexic students.

Accessibility requirements: (1) there must be special fonts for dyslexic learners such as Dyslexie or OpenDyslexic, and (2) there must be a text-to-speech (TTS) function and tasks and exercises that do not require text input.

Interactivity requirements: (1) there must be interactive simulations that visually explain and supplement complex topics, (2) interactive exercises must be provided to stimulate student engagement, and (3) there should be motivational elements, such as a points system, virtual trophies, etc.

Feedback requirements: (1) automated assessment of student progress must be provided, and (2) individual guidance must be provided to learners based on their progress and needs.

Technical integration requirements: (1) metadata must be provided to enable compatibility with learning management systems (e.g., SCORM, AICC, xAPI), (2) WCAG standards must be followed to ensure accessibility for people with different types of disabilities, and (3) compliance with technical standards (e.g., ISO/IEC 40500 [39], ISO 9241-171 [40]) must be ensured. The requirements are represented in the learning object attributes diagram (Figure 9).

Accessibility ensures that content is readable and usable by all students, with features like text-to-speech, adjustable fonts, and color contrast. Interactivity engages learners through dynamic exercises, games, and adaptive learning paths, improving retention and motivation. Feedback provides real-time guidance, helping students recognize mistakes and reinforce correct learning patterns. Finally, technological integration allows for seamless use across various devices and platforms, ensuring that learners can access materials anytime, anywhere, supporting flexible and inclusive education.

The contextual graph shows the process illustrating the sequential introduction of specific tools in the creation of a learning object (Figure 10, Table 3). The process includes content planning, the integration of interactivity and accessibility solutions, and the implementation of technology standards. Each step ensures that the learning object developed meets the expectations and requirements of students with special educational needs.

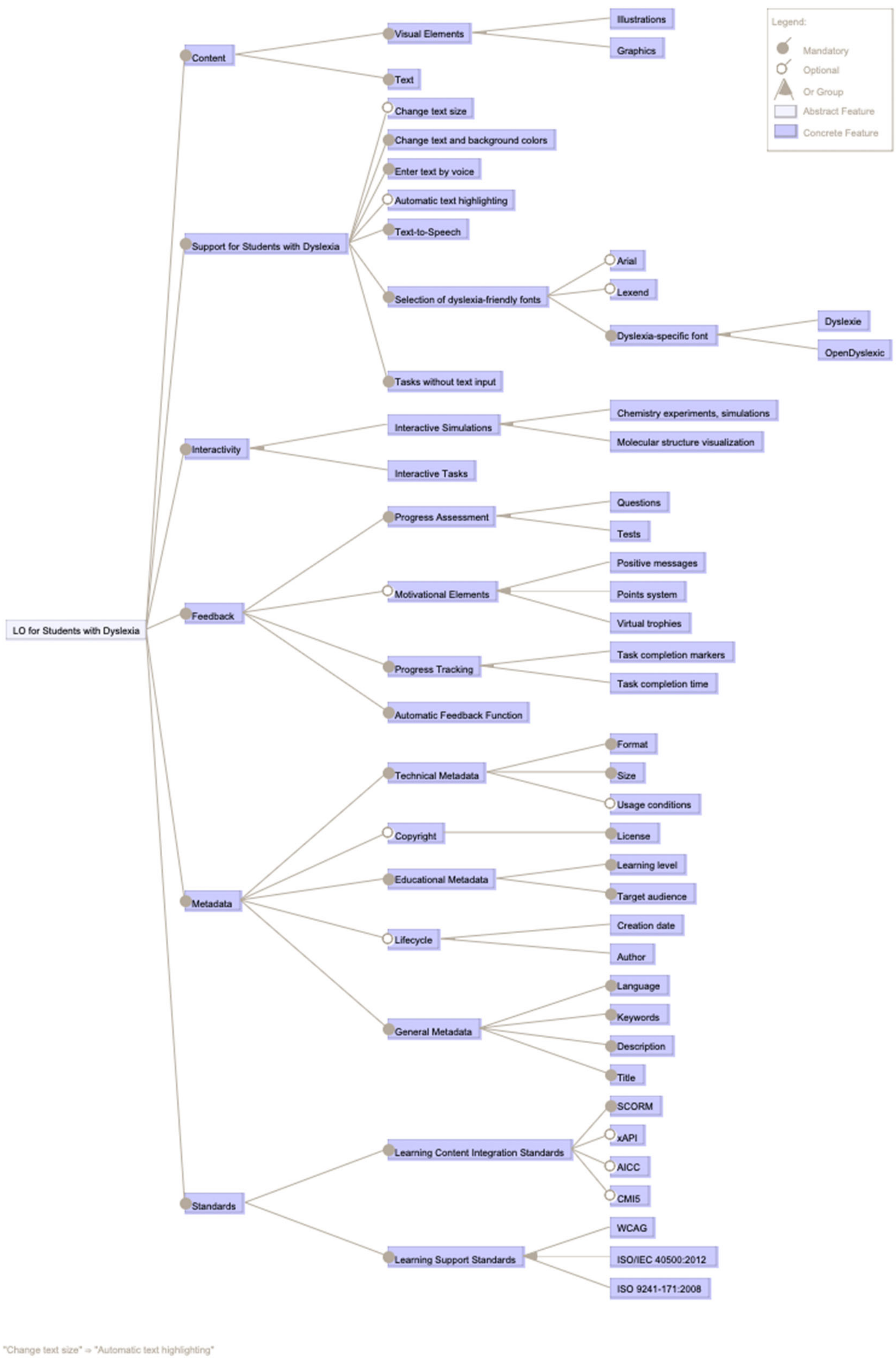

Figure 9. Feature diagram of learning object.

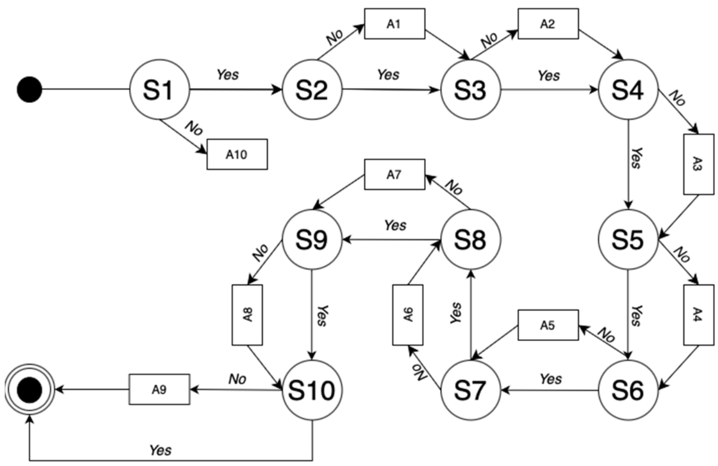

Figure 10. Model for designing learning objects for learners with dyslexia.

Table 3. Conditions and actions.

Condition	Description	Action	Action Description
S1	Is the learning object being designed for students with dyslexia?	A1	Provide textual material.
S2	Are textual elements included?	A2	Include visual elements (illustrations, graphics).
S3	Are visual elements (illustrations, graphics) provided?	A3	Enable text customization features (e.g., adjusting size and colors).
S4	Are text customization features (size, color adjustments) enabled?	A4	Utilize dyslexia-friendly fonts (e.g., OpenDyslexic, Dyslexie).
S5	Is a dyslexia-friendly font being used?	A5	Integrate interactive elements.
S6	Are interactive elements (simulations, tasks) incorporated?	A6	Provide feedback mechanisms.
S7	Are feedback mechanisms (progress assessments, motivational elements) included?	A7	Supply metadata.
S8	Are metadata provided?	A8	Comply with standards (SCORM, xAPI, WCAG).
S9	Are the relevant standards (SCORM, xAPI, WCAG) implemented?	A9	Evaluate the learning object with the target group.
S10	Has the learning object been tested with the target group?	A10	Develop a simple learning object without specialized adaptations.

The focus is on (1) accessibility functionalities such as font size adjustment, voiceover tools and special fonts, (2) deeper interactivity features that help to better absorb more complex learning material, and (3) providing feedback.

Designing a learning object for learners with dyslexia requires accessibility functionalities, deeper interactivity, and effective feedback mechanisms. Accessibility features should include font size adjustment, dyslexia-friendly fonts like OpenDyslexic, and customizable background colors to reduce visual stress. Voiceover tools, text-to-speech, and speech-to-text options ensure that learners can access content through multiple sensory channels, improving comprehension.

Interactivity plays a crucial role in helping learners absorb complex material. Gamified exercises, drag-and-drop activities, and adaptive learning paths provide an engaging and structured experience. Visual aids, interactive diagrams, and hands-on simulations support comprehension by presenting information in multiple ways. Self-paced learning with progressive difficulty levels helps prevent cognitive overload, allowing students to process information at their own speed.

Providing timely and constructive feedback is essential for dyslexic learners. Immediate feedback through audio, visuals, or guided prompts helps reinforce understanding. AI-driven adaptive responses and error-highlighting tools guide learners without discouraging them. Alternative assessments, such as oral responses or multimedia submissions, ensure that students can demonstrate their knowledge in ways beyond traditional text-based formats.

By integrating accessibility, interactivity, and feedback, learning objects become more inclusive, allowing dyslexic learners to engage, process, and retain information effectively.

Successful development of a learning object requires not only the right learning content but also technological solutions that ensure interactivity, usability, and accessibility. The eXeLearning tool chosen for this work is a tool that is versatile and can be used to create different types of learning objects. The standard functionality of this tool can be extended to personalize the content and to adapt it to learners with special needs. HTML, CSS, and JavaScript solutions have been used for this purpose (see Figure 11).

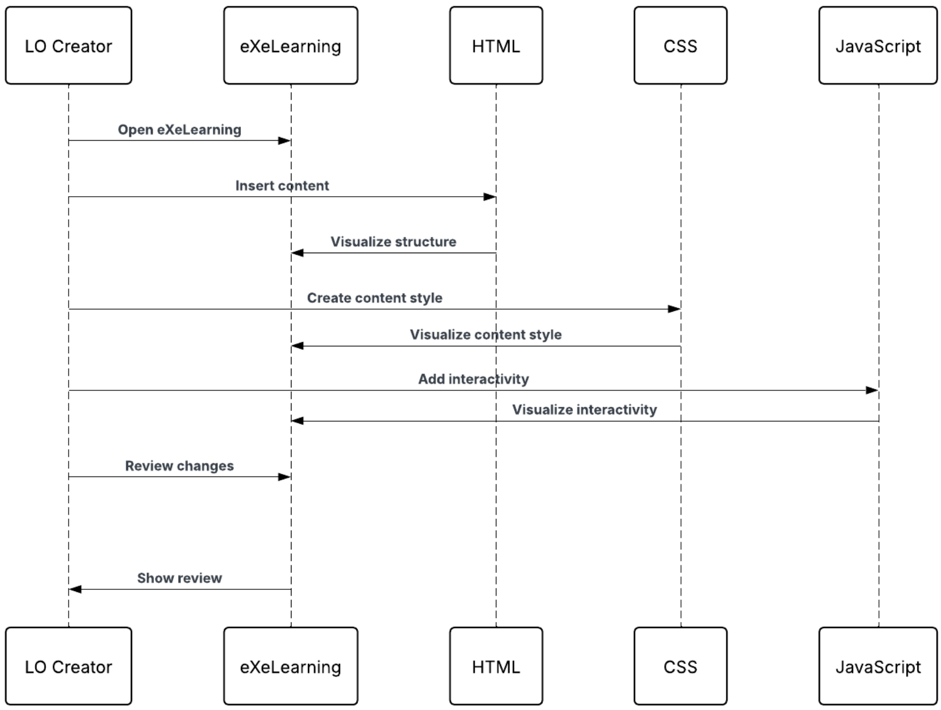

Figure 11. HTML, CSS, and JavaScript solutions.

It is important to present the sequences of possible actions of the learner and their relation to other components of the system. The learner's steps in interacting with the learning management system (LMS) and the learning objects (LOs) include viewing content, completing tasks, and receiving feedback. These steps describe the logic of the learner's interaction with the system and identify how each component of the system contributes to a smooth learning process. The learner's sequence of actions is shown in Figure 12.

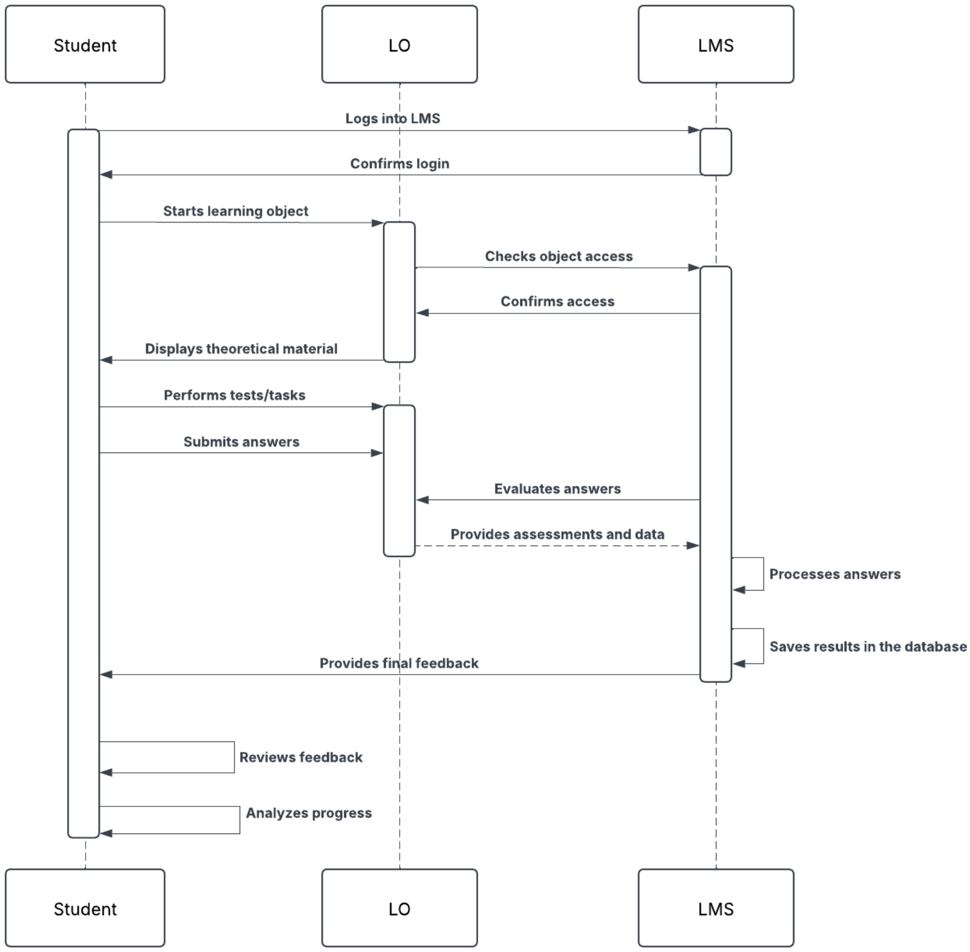

Figure 12. Learner actions.

5.2. Delivering Student Support in Learning Facilities

The cases of interactive learning tasks (Figure 13), presented in accordance with the Universal Design for Learning (UDL) and web content accessibility guideline (WCAG) standards, were designed to ensure accessibility for dyslexic students. The technological solutions for the tasks were implemented using HTML, CSS, and JavaScript, creating a functional, attractive, and easy-to-understand interaction environment. These solutions also help to actively involve students in learning activities.

HTML is used to structure the activities, and the drag-and-drop functionality allows the learner to group the names of chemical elements into appropriate categories such as "Metals" and "Non-metals". Interactive cards, which are presented as clickable cards on different elements, allow for additional information to be accessed, e.g., boiling points of the chemical elements, etc. In the periodic table, each element is represented by a button which the user can click to mark his/her choice. Such interactive functionalities allow the student to practice recognizing and associating information with visual symbols.

The visual solutions implemented by CSS contribute to the comprehensibility and clarity of tasks. Large, easy-to-read fonts and high contrast between text and background make it easier for students to grasp information. The color accents used for the different cards and parts of the tasks help students to quickly navigate the content and focus on the most important details. This visual hierarchy is in line with the WCAG's principle of perceivability, which ensures that information is easily assimilated.

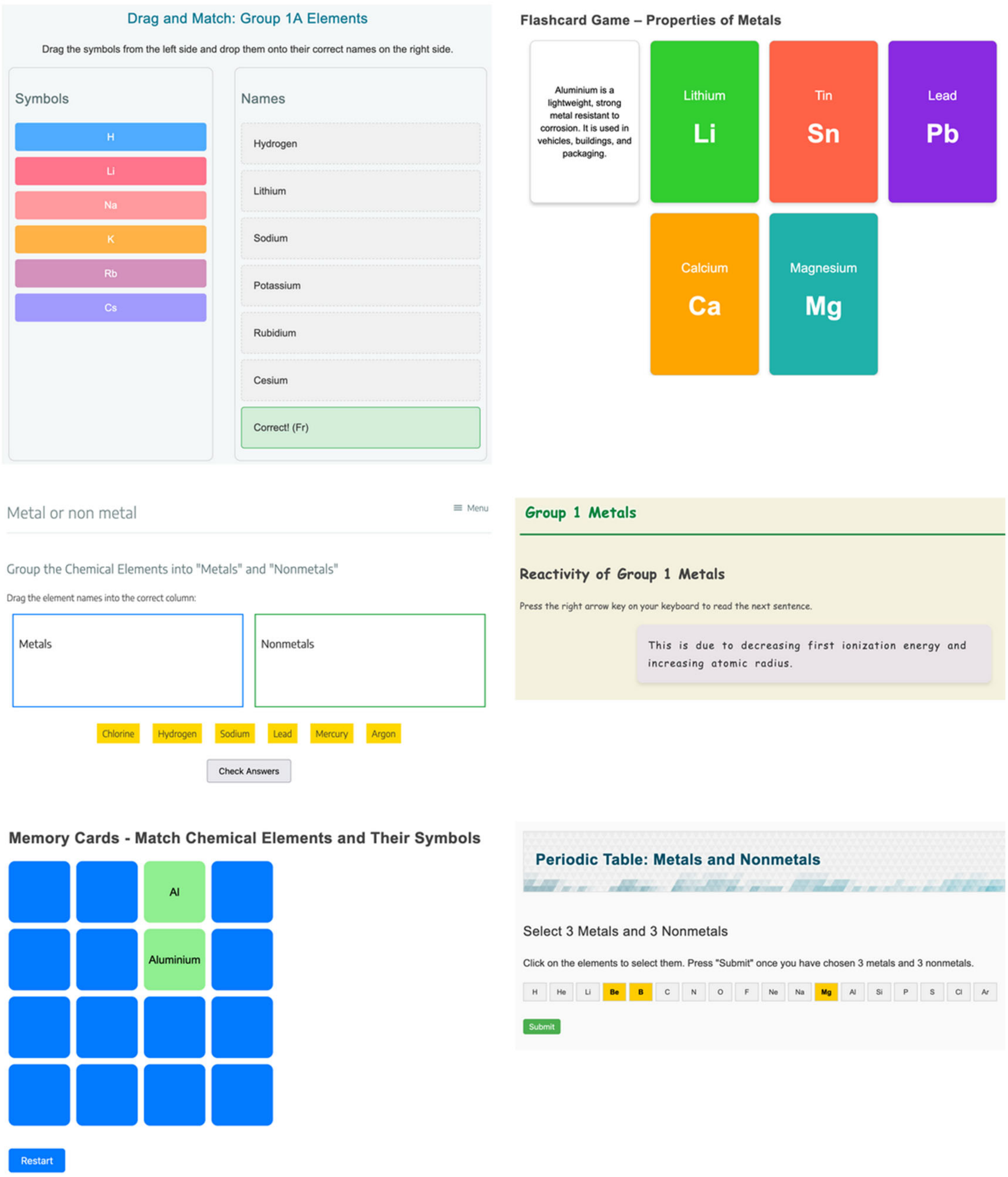

Figure 13. Types of interactive learning tasks.

JavaScript provides interactivity and dynamism. The tabbing mechanism allows for additional information to be revealed after a user action, while the drag-and-drop functionality allows for the stretching of elements and the automatic checking of responses. In addition, JavaScript enables feedback when the student submits answers, as well as flexibility in text browsing—the student can change sentences or view values at their own pace.

The technology solutions also implement the WCAG principles of being operable, understandable, and robust. The interactive elements are designed to be usable with both mouse and keyboard, which is important for users with different needs. Simple instructions, a consistent layout of tasks, and a variety of learning methods (e.g., through interaction, visualization, or gamification) meet the requirements for understandability. The compatibility of the content with different devices and browsers ensures accessibility for all users.

The principles of the Universal Design for Learning (UDL) are realized through the varied presentation of information, the encouragement of students' active involvement, and flexible forms of response, all of which ensure that individual learning needs are met. The presentation of information through visual and interactive tasks enables students to make their own choices and develop practical skills, while allowing the learning process to be adapted to their individual pace. The technological solutions implemented contribute to a reduction in cognitive fatigue, which contributes to more effective learning content and the long-term retention of knowledge. Thus, this case of applying Universal Design principles enables students to participate equally in the educational process, regardless of the diversity of their abilities and needs.

The OpenDyslexic font was introduced to make reading easier for students with dyslexia (Figure 14). The letters of the font have distinctive shapes and a reinforced base that gives an effect of stability and reduces the possibility of confusion between similar letters, such as "b" and "d" or "p" and "q". The increased spacing between letters and words reduces visual density and eye fatigue and helps you to focus on the text.

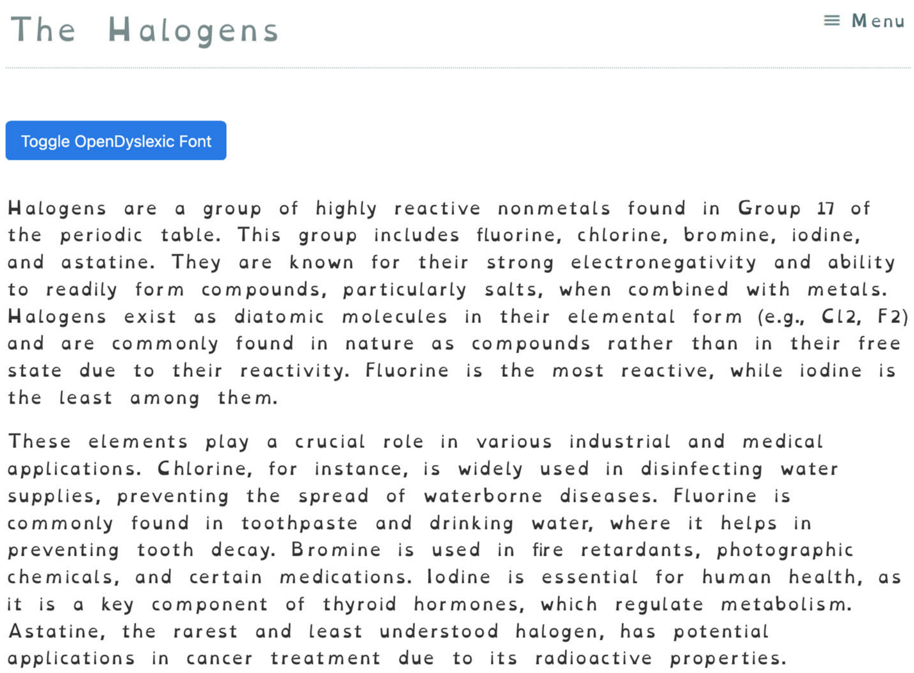

Figure 14. The application of the OpenDyslexic font in the learning object.

The option to switch OpenDyslexic font on or off allows students to adapt the text to their own needs, making learning more comfortable and accessible.

6. Discussion

The findings of this study highlight the importance of specific functionalities in learning objects that support dyslexic learners. Features such as the ability to change text size and font, segment content into smaller parts, and minimize the amount of text on screen were rated the highest by experts. These results are consistent with existing research, which shows that visual load and typographic choices directly impact text readability and comprehension for students with dyslexia [15,23].

Moreover, the emphasis on customization aligns with accessibility standards outlined in the web content accessibility guidelines (WCAGs) [14,38]. These guidelines stress the importance of making digital content perceivable, operable, and understandable, corresponding with functionalities like visual clarity, keyboard navigation, and multimodal access.

Feedback from the open-ended responses further reinforced these priorities. Specialists emphasized the significance of allowing learners to control how they engage with content, offering auditory support and enabling voice input when needed. This approach supports the Universal Design for Learning (UDL) framework, which promotes multiple means of representation and expression to accommodate diverse learning needs [16].

The results of this study also relate closely to instructional design principles such as those found in the ASSURE model, which emphasizes adapting materials to the characteristics and needs of learners [21]. The functionalities most highly rated by specialists—particularly those enabling content differentiation, accessibility adjustments, and feedback—mirror the "Select Media and Materials" and "Utilize Media and Materials" stages of the ASSURE model, highlighting a user-centered and accessible approach to digital learning design.

Importantly, this study also aimed to verify two research hypotheses. The first hypothesis predicted that accessibility-related features, such as the ability to customize text size, font, and background color, as well as the presence of text-to-speech functionality, would be considered the most essential by specialists working with dyslexic students. The empirical findings confirmed this prediction, as functionalities like text size adjustment (M = 4.90), content segmentation into smaller parts (M = 4.76), and limiting the amount of text per screen (M = 4.71) were rated as the most important features. These findings align with previous research that emphasizes the role of visual presentation and accessibility tools in enhancing reading comprehension among dyslexic learners [15,23].

The second hypothesis posited that the prioritization of features by specialists would reflect established principles from inclusive education frameworks, particularly the Universal Design for Learning and instructional design models like ASSURE. This hypothesis was likewise confirmed. Respondents highlighted the importance of multimodal content delivery (visual and auditory), learner autonomy in content interaction, and structured, step-by-step material presentation. These preferences are fully consistent with the core tenets of UDL [16] and support the systematic, learner-centered approach advocated by the ASSURE model [21].

Further qualitative feedback emphasized the need for flexible presentation of content—allowing learners to choose visual, auditory, or interactive modes based on their preferences—which supports findings by Blažienė and Šuminas [13] on the effectiveness of multimodal, customizable learning environments for dyslexic learners. Similarly, the importance placed on step-by-step instructions and a reduction in textual complexity aligns with the recommendations by Snowling and Hulme [11], who advocate minimizing cognitive load to improve comprehension among dyslexic readers.

The findings of this study are especially significant within the context of Lithuania, where educational policy encourages more inclusive approaches but lacks concrete guidance for digital learning environments [10]. By identifying the functionalities most valued by educational specialists, this study provides practical recommendations for the development of inclusive, accessible learning tools that can support dyslexic students more effectively in both national and international contexts.

7. Limitations of the Study

This study has several limitations that should be considered when interpreting the results. First, the sample size was relatively small (n = 21) and was selected using purposive sampling. Although participants were professionals experienced in working with students with dyslexia, the sample may not fully represent the diversity of perspectives across different educational settings or countries.

Second, this study relied solely on descriptive statistical analysis. While this approach was suitable for the exploratory nature of the research, it did not allow for examination of relationships between variables or testing for statistical significance. Consequently, no causal inferences can be drawn, and the findings should be interpreted as indicative rather than conclusive.

Third, although a prototype of a digital learning object was developed based on the findings, it was not tested with students or practitioners. As a result, the effectiveness of the proposed functionalities in real educational contexts remains unvalidated.

Finally, this study is context-specific, with references and practices often relating to the Lithuanian education system. This might limit the generalizability of the findings to other countries with different educational policies, support structures, or levels of technological integration.

Future studies should consider larger and more diverse samples, include direct testing of learning object prototypes with target users, and employ inferential statistical methods to deepen the understanding of the effectiveness of specific design features.

8. Conclusions

In this study, we discussed the research highlighting that dyslexia can have a negative impact on educational performance, self-esteem, and learning outcomes. Theoretical and practical solutions to help students with dyslexia include personalized educational approaches, tailored learning tools, interactive digital resources, and technological aids.

The digital tools examined, such as eXeLearning, Adobe Captivate, and H5P, offer a range of features that allow for the creation of interactive and personalized content. Most of the tools provide the possibility of integrating plug-ins, using different forms of multimedia, and creating interactive activities. The analysis also showed that not all tools fully meet the requirements of learners with special educational needs, such as dyslexia, as some tools have limited support for accessibility standards (e.g., WCAG).

The analysis showed that models such as ADDIE, ASSURE, Pebble-in-the-Pond, and Dick & Carey are suitable for the development of learning objects, but their effectiveness depends on educational needs. The ASSURE model emphasizes the tailoring of learning objects to different user groups, with a particular focus on accessibility, student support, and technology integration. For dyslexic learners, the most appropriate models are those that emphasize interactivity, easy-to-understand content, and access to additional support tools.

Author Contributions: Conceptualization, D.I.; methodology, D.I.; formal analysis, D.I. and D.G.; writing—original draft preparation, D.I.; writing—review and editing, D.G.; visualization, D.I. All authors have read and agreed to the published version of the manuscript.

Funding: This research did not receive any external funding.

Institutional Review Board Statement: Ethical review and approval were waived for this study, as this study involves no more than minimal risk to subjects.

Informed Consent Statement: Informed consent was obtained from all subjects involved in this study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Lyon, G.R.; Shaywitz, S.E.; Shaywitz, B.A. A definition of dyslexia. *Ann. Dyslexia* **2003**, *53*, 1–14. [CrossRef]
2. Pugh, K.R.; Mencl, W.E.; Shaywitz, B.A.; Shaywitz, S.E.; Fulbright, R.K.; Constable, R.T.; Skudlarski, P.; Marchione, K.E.; Jenner, A.R.; Fletcher, J.M.; et al. The neurobiology of reading and dyslexia. *Biol. Psychiatry* **2000**, *48*, 286–293.

3. Thomas, C.; Simos, P.G.; Rezaie, R. Neurobiological and genetic bases of developmental dyslexia. *Front. Hum. Neurosci.* **2021**, *15*, 682719. [CrossRef]
4. Erbeli, F.; Rice, M.; Paracchini, S. Insights into dyslexia genetics research from the last two decades. *Brain Sci.* **2022**, *12*, 27. [CrossRef]
5. Downing, C.; Caravolas, M. Phoneme representation and articulatory impairment in dyslexia. *J. Speech Lang. Hear. Res.* **2020**, *63*, 1257–1270. [CrossRef]
6. Wagner, R.K.; Zirps, F.A.; Edwards, A.A.; Wood, S.G.; Joyner, R.E.; Becker, B.J.; Beal, B. The prevalence of dyslexia: A new approach to its estimation. *J. Learn. Disabil.* **2020**, *53*, 354–365. [CrossRef] [PubMed]
7. Khateb, A.; Bar-Kochva, I.; Breznitz, Z. The differences in semantic processing of pictures and words between dyslexic and typical readers. *Psychology* **2019**, *10*, 450–463. [CrossRef]
8. Khan, A.; Khan, S.; Haider, Z.; Alam, M. A review of artificial intelligence-based dyslexia detection. *Diagnostics* **2023**, *14*, 2362. [CrossRef]
9. Barkauskienė, R. Su Disleksija Galima Susidraugauti—Svarbu Laiku Suteikti Pagalbą [One Can Befriend Dyslexia—It Is Important to Provide Timely Support]. Bernardinai. 2015. Available online: https://www.bernardinai.lt/2015-09-15-r-barkauskiene-su-disleksija-galima-susidraugauti-svarbu-laiku-suteikti-pagalba/ (accessed on 2 January 2025).
10. Lietuvos Respublikos Švietimo, Mokslo ir Sporto Ministerija. Rekomendacijos dėl Atnaujinamų Programų Pritaikymo Specialiųjų Ugdymosi Poreikių Turintiems Mokiniams [Recommendations for Adapting Renewed Programs for Students with Special Educational Needs]. National Agency for Education. 2022. Available online: https://www.nsa.smm.lt/2022/04/29/rekomendacijose-atnaujinamu-programu-pritaikymas-specialiuju-ugdymosi-poreikiu-turintiems-mokiniams/ (accessed on 2 January 2025).
11. Snowling, M.J.; Hulme, C. Interventions for children's language and literacy difficulties. *Int. J. Lang. Commun. Disord.* **2012**, *47*, 27–34. [CrossRef]
12. Blažienė, A.; Šuminas, M. Technologijų taikymas disleksiją turinčių vaikų ugdyme. *Inf. Moksl.* **2022**, *89*, 112–125.
13. Brown, A.; Green, T. Evaluation of functionality in authoring tools for instructional content development. *Int. J. Instr. Technol. Distance Learn.* **2016**, *13*, 3–14.
14. Graf, A. Exploring the role of personalization in adaptive learning environments. *Int. J. Softw. Eng. Comput. Sci. (IJSECS)* **2023**, *3*, 50–56. [CrossRef]
15. Gordillo, A.; Barra, E.; Quemada, J. Enhancing K-12 science education through a multi-device web tool to facilitate content integration and e-Infrastructure access. In Proceedings of the 7th International Technology, Education and Development Conference (INTED2013), Valencia, Spain, 4–6 March 2013; pp. 6515–6523.
16. Supriatna, A.; Ediyanto, E. The implementation of multisensory technique for children with dyslexia. *Indones. J. Disabil. Stud.* **2021**, *8*, 279–293. [CrossRef]
17. Taylor, D.L.; Yeung, M.; Bashet, A.Z. Personalized and adaptive learning. In *Innovative Learning Environments in STEM Higher Education: Opportunities, Challenges, and Looking Forward*; Springer: Cham, Switzerland, 2021; pp. 17–34.
18. Tentama, T.; Sari, D.R.; Maulana, H. The use of eXe-Learning in creating e-modules to improve students' understanding of uniformly accelerated motion. *AIP Conf. Proc.* **2023**, *2580*, 030001.
19. Branch, R.M. *Instructional Design: The ADDIE Approach*; Springer Science & Business Media: New York, NY, USA, 2009.
20. Cheung, L. Using the ADDIE model of instructional design to teach chest radiograph interpretation. *J. Biomed. Educ.* **2016**, *2016*, 9502572. [CrossRef]
21. Aldoobie, N. ADDIE Model. *Am. Int. J. Contemp. Res.* **2015**, *5*, 68–72.
22. Peterson, C. Bringing ADDIE to life: Instructional design at its best. *J. Educ. Multimed. Hypermedia* **2003**, *12*, 227–241.
23. Mishra, P.; Koehler, M.J. Technological pedagogical content knowledge: A framework for teacher knowledge. *Teach. Coll. Rec.* **2006**, *108*, 1017–1054. [CrossRef]
24. Batır, Z.; Sadi, Ö. A science module designed based on the ASSURE model: Potential energy. *J. Inq. Based Act.* **2021**, *11*, 111–124.
25. Gagné, R.M.; Wager, W.W.; Golas, K.C.; Keller, J.M. *Principles of Instructional Design*, 5th ed.; Cengage Learning: Mason, OH, USA, 2005.
26. Allen, M.W.; Merrill, M.D. SAM and Pebble-in-the-Pond: Two alternatives to the ADDIE model. In *Trends and Issues in Instructional Design and Technology*, 4th ed.; Reiser, R.A., Dempsey, J.V., Eds.; Pearson: London, UK, 2017; pp. 31–41.
27. García, R.; Pacheco, C. Development of interactive learning objects: A review of tools and methods. *J. Educ. Technol. Soc.* **2018**, *21*, 29–40.
28. Wilson, J.; Stacey, E. Integrating learning objects into learning management systems: Challenges and solutions. *Australas. J. Educ. Technol.* **2004**, *20*, 20–35.
29. Dick, W.; Carey, L.; Carey, J.O. *The Systematic Design of Instruction*, 8th ed.; Pearson: London, UK, 2015.
30. Merrill, M.D. A pebble-in-the-pond model for instructional design. *Perform. Improv.* **2002**, *41*, 39–44. [CrossRef]
31. Smith, S.J.; Okolo, C. Response to intervention and evidence-based practices: Where does technology fit? *Learn. Disabil. Q.* **2010**, *33*, 257–272. [CrossRef]

32. Tentama, T.; Riskiyana, E.R. The use of Adobe Captivate in creating French literature learning materials. *J. Educ. Learn. (EduLearn)* **2024**, *18*, 136–143.
33. Patel, S.R.; Margolies, P.J. A comparison of e-learning authoring tools for medical education. *J. Med. Educ. Curric. Dev.* **2020**, *7*, 2382120520915495.
34. Kelly, B.; Petrie, H.; Sloan, D.; Lauke, P.; Brown, S.; Ball, S.; Seale, J. Accessibility 2.0: People, policies and processes. In Proceedings of the 2007 International Cross-Disciplinary Conference on Web Accessibility (W4A), Banff, AB, Canada, 1 May 2007; ACM: New York, NY, USA, 2007; pp. 138–147. [CrossRef]
35. eXeLearning. eXeLearning: Open-Source Content Authoring Tool. Available online: https://exelearning.net/en/ (accessed on 2 January 2025).
36. Syahputra, A.; Amin, M. Implementation of Adobe Captivate in creating digital content e-learning. *J. Phys. Conf. Ser.* **2019**, *1360*, 012034.
37. Lei, G. Influence of ASSURE model in enhancing educational technology. *Interact. Learn. Environ.* **2023**, *32*, 3297–3313. [CrossRef]
38. Cooper, M.; Sloan, D.; Kelly, B.; Lewthwaite, S. A challenge to web accessibility metrics and guidelines: Putting people and processes first. In Proceedings of the 2012 International Cross-Disciplinary Conference on Web Accessibility (W4A), Lyon, France, 16–17 April 2012; pp. 1–10.
39. *ISO/IEC 40500:2012*; Information Technology—W3C Web Content Accessibility Guidelines (WCAG) 2.0. ISO: Geneva, Switzerland, 2012.
40. *ISO 9241-171:2008*; Ergonomics of Human-System Interaction—Part 171: Guidance on Software Accessibility. ISO: Geneva, Switzerland, 2008.