Exploring the Experiences of Online and Distance Learners with Visual Impairments in Regard to AI-Assisted Narration

RESEARCH ARTICLES

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ABSTRACT

Ensuring accessibility in open and distance learning (ODL) environments is essential to ensuring equal opportunity. Audio learning resources play a particularly important role in enabling individuals with visual impairments to participate independently in ODL. This qualitative case study explored how learners with visual impairments engaged with AI-assisted audio versions of a learning material and how perceived voice characteristics, including voice gender, shaped their learning experiences. The learning material was converted to speech using an AI text-to-speech tool and produced in two versions (female and male voices) with identical technical parameters. Participants were sixteen learners with visual impairments who accessed the audio materials before semi-structured telephone interviews. Data were transcribed and analyzed using thematic analysis. Findings indicated that participants viewed AI-assisted audio not merely as an accessibility supplement but as a central component of independent study within ODL. Voice characteristics shaped perceptions of comfort, concentration, and cognitive effort. While clarity and consistency were valued, limitations in naturalness, prosody, and pausing increased mental effort during prolonged listening. Learners mitigated these challenges through self-regulated strategies such as adjusting playback speed, replaying segments, and segmenting the content. The study offers user-informed design implications for scalable and inclusive audio production in ODL, highlighting the pedagogical importance of voice design decisions in AI-assisted accessibility practices.

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INTRODUCTION

Among innovative educational technologies, artificial intelligence (AI) stands out as an effective tool in helping learners with visual impairments overcome barriers in both physical and digital environments, thanks to the personalized learning experiences it offers and the ease of access to information it provides (Tsouktakou et al., 2024). The literature examines the transformative function of AI through a comprehensive lens of inclusivity. Filipova (2025) argues that AI is not merely an assistive tool but also an instrument of equity that enhances students' social integration and self-confidence. In this context, she clearly emphasizes a correlation between personalized learning pathways and the learner's capacity for independent mobility/learning. In UNESCO's guide on the use of AI in higher education, Sabzalieva and Valentini (2023) highlight the potential of these technologies to provide personalized support and enhanced accessibility, particularly for students with disabilities. This emphasis also aligns with views that AI-assisted voice technologies, when adapted to learners' individual needs, strengthen equal opportunity within the educational ecosystem. Similarly, Almufareh et al. (2024) note that AI-enabled technologies not only increase the accessibility of content but also enhance learning processes from a pedagogical perspective and turn disability inclusion into an institutional strategy. On the other hand, Koranteng (2025) argues that AI-driven assistive technologies are not limited to a single type of disability; rather, they serve as a universal lever transforming academic participation across the education ecosystem.

The text-to-speech conversion and voice-cloning capabilities of generative AI mark a new stage in enriching ODL resources. Contemporary AI systems can transform written texts into high-quality, fluent audio content that closely resembles human narration. In their study within the context of this developing industry, Inamdar et al. (2023) provided a largely technical overview of how these technologies have impacted content production across various fields, including education and entertainment. Research has shown that AI-assisted voice technologies can produce speech that is highly human-like, context-sensitive, and optimized for intonation, emphasis, and rhythm (Kane et al., 2024; Chan & Kuang, 2024). The quality of accessible instructional content is particularly critical for learners with visual impairments, as inadequately designed video and audio materials can limit independent access to course content and increase reliance on external support (Wilkens, 2025).

This technological transformation promises a more autonomous learning experience for learners with visual impairments by enabling them to study at their own pace and according to their preferences, without relying on others (Yang & Taele, 2025). Research shows that faculty members consider this technology a reliable form of support, which increases productivity, and that students react to synthetic voices in ways that closely resemble natural human speech (Leong et al., 2023). Indeed, Kim et al. (2022) state that integrating AI technologies into learning resources contributes to creating an effective and efficient learning environment. Pi et al. (2022) conducted experimental research on the impact of AI-assisted voices and visual stimuli, particularly in video lectures, on student psychology. They concluded that AI technologies can enhance learners' motivation, engagement, and attention compared with traditional methods.

For online and distance learners with visual impairments, engagement with course content is commonly supported by digital access technologies such as screen readers and related auditory assistive technologies (Amponsah & Bekele, 2023; Pacheco et al., 2018; Tlili et al., 2024). At the same time, previous research shows that access is not always seamless, as students may encounter barriers related to inaccessible digital materials and other features of online learning environments (Guddad, 2025; Koçdar & Bozkurt, 2023; Shaheen, 2025). These issues are particularly visible in media-rich higher education contexts, where the accessibility of instructional materials remains a significant concern for students with visual impairments (Wilkens, 2025).

Recent studies further show that AI-assisted content can support the quality of life and academic autonomy of learners with visual impairments. Research examining the impact of large language models (LLMs) on the academic success of university students with visual impairments has demonstrated that these tools directly improve students' quality of life, and that this improvement may indirectly contribute positively to academic success (Elshaer et al., 2025). Beyond these improvements, positioning AI as an independent assistant also seems to directly strengthen personal autonomy. Recent studies testing AI-assisted content emphasize that the need of learners with visual impairments for assistance from others decreases markedly, which significantly increases perceived autonomy and independence in academic processes (Marquez-Carpintero et al., 2025).

Integrating AI technologies into educational materials should not be evaluated solely as a technical achievement; what lies at the centre of this integration is the learner's interaction with the technology. Current research suggests that the quality, speed, and especially the perceived gender of an AI-assisted voice (Pias et al., 2024) can profoundly affect learners' information processing, technology acceptance, and motivation. Mogali et al. (2024) highlight that monotonous artificial voice tone, unnatural speaking speed, incorrect stress patterns, and pronunciation problems may negatively affect the learning experience. For learners with visual impairments, overly mechanical or insufficiently expressive synthetic speech may reduce engagement with instructional content and make auditory processing less fluent. Therefore, AI-based voices should be intelligible, natural-sounding, and aligned with the pedagogical and affective demands of instructional design (Papadopoulos et al., 2010; Papadopoulos et al., 2009; Walczak & Fryer, 2017).

This requirement underscores the necessity for experience-based, systematic research to inform the design of AI voice technologies that learners accept and perceive as having a "human touch". Such research is intended to guide their integration into ODL ecosystems. However, most extant studies prioritize the quantitative assessment of the technical quality of AI voices. While a limited number of recent studies have begun to explore the mental models, autonomy gains, and interactions of visually impaired individuals with generative AI (Adnin & Das, 2024; Flores-Saviaga et al., 2025; Sharma et al., 2025), a critical research gap remains. The pedagogical experience of these learners when interacting with AI-assisted instructor voices remains largely unexplored. This is particularly true regarding perceived voice characteristics, cognitive load management, and autonomous study practices during prolonged engagement with authentic course materials in an ODL context. To address this specific gap, this study moves beyond technical evaluations to explore AI-assisted voiceover not merely as an assistive tool but as a systemic, institutional educational intervention. By examining the cognitive, affective, and self-regulatory interactions of visually impaired learners with both female and male AI narrators, this study provides an empirical, user-centered roadmap for designing distance education.

PURPOSE OF THE STUDY

This study aims to investigate in depth the interactions of learners with visual impairments in an ODL context, specifically regarding AI-assisted audio versions of educational content. In this context, the study evaluates how AI-assisted audio learning resources and the narrator's gender shape learning processes. In line with this aim, the study seeks to answer the following questions:

For learners with visual impairments:

1. What are their habits of using learning resources?
2. What are their usage patterns regarding AI-assisted audio content?
3. What are the reasons behind their preferences regarding the narrator's gender?
4. What are their cognitive and affective perceptions (feelings, thoughts, perceptions) of AI-assisted audio content?
5. How do they evaluate the structural features of the AI voice (tone, speed, quality)?
6. What are their expectations and recommendations regarding the use of AI-assisted audio resources?

METHODS

RESEARCH DESIGN

In line with the aim of this research and its research questions, a qualitative case study approach was adopted. The focus of the study was to examine the usage patterns, experiences, and engagement with AI-assisted audio content among learners with visual impairments. Case studies enable an in-depth exploration of a contemporary phenomenon within its natural context (Merriam & Tisdell, 2016; Stake, 1995; Yin, 2003). This study investigates the usage patterns, experiences, and engagement with an AI-assisted audio course material in ODL environments by learners with visual impairments. Specifically, the case centers on the implementation of AI-assisted audio narration as an accessibility intervention in the Behavioral Sciences course offered by the Faculty of Open Education at Anadolu University.

PARTICIPANTS

Anadolu University Open Education Faculty is a large-scale distance education provider offering fully online undergraduate programs delivered through a centralized learning management system (Bozkurt, 2025). Courses are designed for asynchronous access and primarily rely on text-based instructional materials. The Behavioral Sciences course, which constitutes the focus of this study, is a compulsory course within the program and is offered to a large and diverse student population, including learners with visual impairments. Participants were recruited from this institutional context, ensuring that their experiences with the AI-assisted audio narration were situated within their authentic learning environment.

Participants were selected using criterion sampling, a purposive sampling strategy. Accordingly, the following criteria were used:

1. Having a medically diagnosed visual impairment (blind or low vision).
2. Being enrolled in an ODL program in which the Behavioral Sciences course offered by the Faculty of Open Education at Anadolu University is compulsory.
3. Having prior experience with audio content.

A total of 16 volunteer learners (8 women, 8 men) who met the criteria participated in the study. The AI-assisted audio content was created by generating a voiced version of one unit from the course textbook used in the ODL program. Learners enrolled in the program in which the course is compulsory were included to ensure coherence between the course content and their academic context.

RESEARCH PROCEDURES

Ethics approval was obtained from the Anadolu University ethics committee prior to the research (Date: 5 May 2025; Protocol No: 878479). The audio materials used in the study were produced by selecting one unit of the Behavioral Sciences course textbook and using the ElevenLabs program, which provides AI-based text-to-speech technology. The selected unit exemplifies the course's instructional design, comprising conceptually dense, text-based content that demands sustained reading and comprehension. It includes explanatory passages, conceptual definitions, and embedded assessment elements such as practice questions. This type of material was considered particularly suitable for audio transformation, as it reflects the core learning demands placed on students in the ODL environment. The model used was Eleven Turbo v2.5. Female and male narrations were generated from the same text using identical technical settings to control for content-based variables. The selected unit was scripted to suit listening-based learning. In this process, punctuation was edited, expressions dependent on visual context were adapted into an auditory narrative, and tables and visuals were described and integrated into the audio content. The script contains approximately 54,000 characters. Trial narrations were produced to bring intonation and stress patterns closer to natural speech, and necessary linguistic revisions were made. Guiding statements were added to practice questions to support the listener's cognitive engagement, encouraging self-regulated learning strategies such as pausing, thinking, and re-listening. For technical control and traceability, the text was divided into sections and voiced section by section; each section was coded. The resulting recordings were reviewed, and sections perceived as unnatural or overly mechanical were revised and re-voiced. In the final stage, all audio files were combined to create a cohesive recording. This iterative process aimed to optimize the content in terms of both technical quality and auditory naturalness.

DATA COLLECTION TOOLS

Data were collected through semi-structured interviews. The interviews aimed to elicit learners' usage patterns, preferences, and experiences regarding the case under investigation. During the development of the interview protocol, draft questions were first formulated by reviewing the relevant literature on ODL, AI-assisted narration technologies, and accessible learning environments for individuals with visual impairments. The draft interview form was subsequently submitted for expert review, and revisions were made in line with the feedback received to enhance the clarity, comprehensibility, and scope of the questions. To further ensure the instrument's functionality and appropriateness, a pilot interview was conducted with a participant who was not included in the main study sample but possessed similar characteristics. Based on the pilot application, the sequence of questions was reorganized, and terms found to be unclear were replaced with more explicit expressions. The interview questions in the protocol, aligned with the research questions, are presented in Table 1.

Table 1 Purposes and related interview questions aligned with the research questions.

*During the interviews, follow-up probes such as "Could you elaborate on that?", "Could you give an example?", and "How did that make you feel?" were used to help participants describe their experiences in more detail.

RESEARCH QUESTION	PURPOSE	INTERVIEW QUESTIONS
1. How do learners with visual impairments use learning resources?	To identify learners' prior habits, preferred resources, and prior attitudes towards audio content.	Which learning resources do you generally prefer in the learning process? How do you use these resources? Why? Have you used a narrated learning resource before? Which environments or formats do you prefer? Can you give examples of positive or negative experiences?
2. How do learners with visual impairments use AI-assisted audio content?	To understand technical interactions (speed, pausing, etc.) and functional usage patterns.	How did you use the AI-assisted audio content provided in the study? • Did you ever pause and think while listening? • Did you rewind/fast-forward? • Did you listen in one sitting or in parts? • Did you change the playback speed? • Did you use other means while listening (note-taking, making voice recordings, etc.)?
3. What are the reasons underlying preferences regarding voice gender?	To identify preferences regarding voice characteristics (female/male) and the reasons for these preferences.	What are your views on using a female or a male voice in audio content? • Which do you prefer (female/male) and why (trust, timbre, habit, etc.)? • Would you prefer the entire audio content narrated by a single voice or use multiple voices?
4. What are cognitive and affective perceptions of AI-assisted audio content?	To examine the emotions, motivation, and levels of concentration that develop in response to an AI voice	How did you feel while using the AI-assisted audio content? How would you describe this experience? • What positive or negative situations occurred? Did the fact that the audio was AI-assisted make a positive or negative difference to your learning process? • Did it make a difference to your motivation? • Did it make a difference to your focus?
5. How do learners evaluate the structural characteristics of the AI voice (tone, speed, quality)?	To elicit views about the characteristics of the AI voice.	What do you think about the features of the audio content (volume, speaking speed, tone, voice quality, etc.)? • Are there aspects you think are good? If so, what? • Are there aspects that should be improved? If so, what?
6. What expectations and recommendations do learners have?	To evaluate autonomous learning capability with audio resources and the adequacy of the system in this regard.	How does using audio resources affect your study speed and routine? Are audio contents sufficient for you to study the course on your own without help from others? What are your recommendations for using audio contents more effectively in learning environments? Is there anything else you would like to add about audio content usage?

Research data were collected in three stages during the fall semester of the 2025–2026 academic year (pre-interview/information, experience, interview). Throughout the process, a flexible communication strategy was adopted to accommodate the accessibility needs of learners with visual impairments. In the first stage, participants were contacted by telephone, and the purpose, scope, procedures, and voluntary nature of participation were explained in detail. They were informed that they could withdraw at any stage and that data would be evaluated in line with confidentiality principles; informed consent was obtained from learners who agreed to participate. Participants' preferred communication channels were also confirmed. In the second stage, the AI-assisted audio materials were shared via email or SMS according to learner preference, and participants were asked to listen to the content before the scheduled interview date. In the final stage, semi-structured interviews were conducted by telephone. With participant consent, interviews were audio-recorded and stored for analysis. Interviews lasted approximately 25–30 minutes on average.

DATA ANALYSIS

Data analysis was conducted using the strategies suggested by Yin (2018). First, all interviews were transcribed verbatim from audio recordings, and the transcripts were read repeatedly to develop a holistic familiarity with the data. An initial coding process was then conducted, whereby meaningful units of text were identified and assigned descriptive codes reflecting participants' experiences and interactions with the AI-assisted audio content. The coding process was iterative and involved constant comparison across transcripts to ensure consistency and conceptual alignment. Codes with similar meanings were subsequently grouped into broader categories, which were then organized into overarching themes corresponding to the research questions. Accordingly, the findings were organized in a hierarchy that directly reflects the scope and depth of the research questions. The resulting themes were interpreted with support from learner statements, and a holistic analysis was conducted to explain how and why the case emerged as it did. The themes and categories were then checked again against the raw data, and the consistency of interpretations with the data was reviewed.

VALIDITY AND RELIABILITY

To ensure data quality and methodological rigour, strategies suggested by Lincoln and Guba (1985) were employed. To enhance credibility, the researchers engaged with the data over an extended period; interview transcripts and audio recordings were examined in detail through repeated reading and listening. This contributed to developing deep familiarity with the data and identifying meaning patterns more reliably. In addition, expert review was used to minimise potential subjective judgements during analysis and to strengthen consistency. The coding structure and themes were reviewed by an independent researcher, an expert in the field, and revisions were made where necessary. Transferability was supported by providing detailed descriptions of the study group, research context, and learner experiences. Finally, to enhance confirmability, findings were presented with direct quotations from learners, demonstrating transparently that researcher interpretations were grounded in the data.

FINDINGS

The data obtained from the interactions of learners with visual impairments with AI-assisted audio content were analyzed and are presented below in relation to the research questions.

An overview of the emerging themes identified in this study is presented in Table 2.

Table 2 Emerging themes and categories identified in the study.

NO	THEME	CATEGORIES
1	Access experiences in the learning process	Use of digital resources; Screen reader use and human support; Accessibility barriers.
2	Patterns of using AI-assisted audio content	Listening session preferences; Control and interaction with the content; Note-taking and re-access.
3	Preferences regarding voice gender	Preferences based on technical performance; Affective and symbolic perceptions; Perceptions of naturalness and artificiality; Single vs. multiple voices.
4	Cognitive load and affective perceptions	Mental fatigue; Need for forced focus; Need for segmentation and time management.
5	Evaluations of the structural features of the AI voice	Perceived lack of emotion; Robotic timbre and mechanical quality; Clarity and intelligibility; Stable voice that does not tire.
6	Instructional design expectations	Demand for past exam questions and mock tests; Overcoming PDF-related accessibility issues; Interface simplicity and access speed; Linguistic improvements.

FINDINGS ON LEARNERS' USE OF LEARNING RESOURCES

This section examines learners' general study habits and their use of audio technologies. All learners reported studying in digital environments, most commonly through mobile applications, the e-learning platform, and live-class recordings. L1 identified live-class recordings accessed via the mobile application as the main study material, while L2 and L4 similarly described learning through phones, computers, tablets, and other digital materials. These accounts suggest that learning is organized largely through digital tools.

For learners with visual impairments, access was predominantly audio-based. Screen readers such as VoiceOver and TalkBack were central to access to content. As L3 noted:

> *"I use it on my phone. Because I have a visual impairment, there is VoiceOver, a screen reader. I use it thanks to that" (L3).*

L9 similarly reported accessing questions through TalkBack. However, some learners still required human support. L1 explained:

> *"I have my cousin nearby. Usually, they open it. If they are not there, I can't listen" (L1).*

Participants also reported accessibility barriers in existing audio and digital materials. These included mispronunciation and insufficient stress in screen-reader output, disruptions in human narration due to fatigue, limited availability of audio narration, lack of screen-reader integration, and difficulties accessing PDF-based materials (L3, L4, L7, L10, L15). Table 3 summarises the categories related to access experiences in the learning process.

Table 3 Categories related to the theme 'Access experiences in the learning process'.

THEME	CATEGORY	N	DETAILS AND SOURCES
Access experiences in the learning process	Use of digital resources	16	Fully digital learning; mobile apps; lecture recordings (L1, L2, L3, L4).
	Screen reader use and human support	11	VoiceOver/TalkBack use; audio-based learning (L3, L9); need for human support (L1).
	Accessibility barriers	10	Mispronunciation (L3); tone issues (L4); need to convert PDF incompatibility; structural barriers (L7, L10, L15).

FINDINGS ON PATTERNS OF USING AI-ASSISTED AUDIO CONTENT

This section examines learners' interaction patterns with AI-assisted audio content. Use varies according to individual study habits and levels of technical experience. While some learners preferred to listen to the content in a single session, others preferred to listen to it in segments. As L7 explained:

> *"I listened in parts so I could understand. Because one session is very hard. Otherwise, it feels like we listened superficially and just moved on" (L7).*

Learners also differed in how they controlled the content. Some functions were actively used, such as pausing, rewinding, and adjusting playback speed (e.g., L4, L5, L13, L15). For example, L15 stated:

> *"I paused to test whether I understood what was being read. Then I started again" (L15).*

By contrast, others reported listening without intervention, indicating that they found the default speed sufficient (e.g., L1, L3, L7).

Most learners reported not taking notes while listening, mainly because digital access enabled them to return to and replay relevant sections as needed. Some participants, however, reported taking selective notes on important points or using alternative strategies such as creating voice recordings during the exam period (e.g., L7, L11, L14). Table 4 presents the categories related to patterns of using AI-assisted audio content.

These findings indicate that AI-assisted audio content is used in different ways by learners and that usage is shaped by individual learning habits.

THEME	CATEGORY	N	DETAILS AND SOURCES
Patterns of using AI-assisted audio content	Listening session preferences	8	One-session listening; segmented listening; comprehension-driven preference (L2, L6, L7).
	Control and interaction with the content	14	Rewinding/pausing; speed adjustment (L4, L5, L13, L15); self-testing; control-based variation (L1, L3, L7).
	Note-taking and re-access	7	Reduced note-taking (L5); selective notes (L10, L12); re-access via recordings (L14).

Table 4 Categories related to the theme 'Patterns of using AI-assisted audio content'.

FINDINGS ON REASONS FOR PREFERENCES REGARDING VOICE GENDER

This section examines learners' preferences regarding female and male AI voices. Preferences were shaped less by gender itself than by perceived intelligibility, naturalness, and affective qualities. Many learners associated the male voice with clearer pronunciation, stronger stress patterns, and a lower perceived artificiality. For example, L15 stated that:

> *"In terms of intonation, the 'fullness' of the voice, the stress patterns, and pronunciation, it felt more successful" (L15).*

Similarly, some participants described the male voice as more listenable and technically stronger.

By contrast, some learners found the female voice clearer, warmer, and more instructive. L1 described it as more sincere and closer, while others associated it with greater listenability. For some participants, however, gender was not a decisive factor; intelligibility and technical quality were the primary criteria.

Participants' evaluations also reflected perceptions of naturalness and artificiality. Some learners described the female voice as flat or robotic, whereas the male voice was more often perceived as natural. In addition, most learners preferred a single voice, mainly to maintain consistency and avoid distraction. A smaller number suggested that multiple voices might enhance attention by creating variation across courses. Table 5 presents the categories related to preferences regarding voice gender.

THEME	CATEGORY	N	DETAILS AND SOURCES
Preferences regarding voice gender	Preferences based on technical performance	9	Clarity; stress accuracy; fluency; intelligibility as main criterion (L5, L6, L10, L12).
	Affective and symbolic perceptions	6	Female: sincere/gentle; male: serious/reassuring; symbolic associations (L1, L8).
	Perceptions of naturalness and artificiality	4	Female: robotic/flat; male: more natural; link to performance (L13, L15)
	Single voice vs. multiple voices	5	Single voice for consistency (L1, L6, L12); voice changes causing unease (L12); multiple voices increase attention but may distract (L11, L13).

Table 5 Categories related to the theme 'Preferences regarding voice gender'.

FINDINGS ON COGNITIVE LOAD AND AFFECTIVE PERCEPTIONS

This section examines learners' cognitive and affective perceptions of AI-assisted voices. Although AI-assisted narration offered accessibility and speed advantages, many learners reported that its monotonous and emotionless delivery caused mental fatigue, particularly during long listening sessions. As L12 stated:

> *"A serious headache happens. The brain becomes full... Because you get saturated at that moment, it ends. If it were split into at least three parts, we wouldn't get tired. A serious headache happens. The brain becomes full" (L12).*

Several participants indicated that the lack of stress, intonation, and meaningful pauses made it difficult to sustain attention over time. L12 noted that: "*interest and attention scatter after 20 minutes*," while L8 emphasized the importance of stress in maintaining engagement. Some learners also reported coping with this difficulty by listening in shorter segments (e.g., L5).

Overall, these accounts suggest that prolonged exposure to a uniform voice structure may reduce attention and increase listening fatigue. Table 6 presents the categories related to cognitive load and affective perceptions.

Table 6 Categories related to the theme 'Cognitive load and affective perceptions'.

THEME	CATEGORY	N	DETAILS AND SOURCES
Cognitive load and affective perceptions	Mental fatigue	10	Long listening → fatigue; attention loss; difficulty processing words (L8, L12).
	Need for forced focus	7	Extra effort due to monotony; difficulty identifying key points (L5, L8).
	Need for segmentation and time management	4	Preference for shorter segments; micro-learning need (L5, L12).

FINDINGS ON EVALUATIONS OF THE STRUCTURAL FEATURES OF THE AI-ASSISTED VOICE

This section examines learners' evaluations of the AI-assisted voice's structural features. Participants described the AI-assisted voice as both functional and limited. Many learners found it clear and intelligible, whereas others emphasized its lack of emotion, sincerity, and natural intonation. As L2 stated:

> *"There used to be a feeling. They try to give a feeling with AI too, but still, a kind of mechanical quality appears every time… I usually don't rewind. If I start, I finish. But I don't fast-forward. I sometimes speed it up from the back. I sometimes increase the speaking speed" (L2).*

Some learners reported that the mechanical and flat quality of the voice did not always have a negative effect. In some cases, it encouraged closer listening. For example, L15 stated:

> *"Honestly, it didn't affect me negatively at all. On the contrary, I don't know if it's related, but it made me listen more carefully; for example, I listened with more focus. It didn't affect me negatively; on the contrary, it was positive for me." (L15)*

Other participants also noted that, unlike human narration, the AI-assisted voice maintained a stable performance during long readings (e.g., L4, L12).

Overall, participants' accounts suggest that the AI-assisted voice was valued for its clarity and consistency but also perceived as limited in emotional expression and naturalness. Table 7 summarises the categories related to evaluations of the AI-assisted voice's structural features.

Table 7 Categories related to the theme 'Evaluations of the structural features of the AI-assisted voice'.

THEME	CATEGORY	F	DETAILS AND SOURCES
Evaluations of the structural features of the AI-assisted voice	Perceived lack of emotion and 'soullessness'	11	Lack of warmth/sincerity; limited intonation; impersonal delivery (L2)
	Robotic timbre and mechanical quality	9	Metallic/flat tone; monotony (L4, L9); distraction vs. attention effect (L15).
	Clarity and intelligibility	7	Clear pronunciation; fluent reading; fast information access (L2).
	Stable voice that does not tire (continuity)	7	Consistent performance in long readings (L4, L12).

FINDINGS ON EXPECTATIONS AND RECOMMENDATIONS FOR IMPROVEMENT

This section examines learners' expectations regarding AI-assisted audio resources. Participants' suggestions focused mainly on linguistic quality, accessibility, and system usability. The most frequently mentioned linguistic expectations were more appropriate pauses at punctuation marks, improved stress and intonation, and more natural emotional delivery. For example, L13 stated that the AI-assisted voice "*does not wait between commas*," which made it difficult to recognise sentence boundaries.

A prominent expectation concerned the accessibility of past exam questions and mock tests, particularly those presented in PDF format. Participants indicated that these materials were difficult to access independently and suggested integrating them into the application as AI-voiced content. As L13 noted:

> *"That part with past questions is never accessible in the mobile application… Having AI read these would be perfect" (L13).*

Participants also emphasized the importance of interface simplicity and system speed. Some reported that technical problems and slow or complex navigation negatively affected usability. For example, L16 stated, "*I would click the link, and it wouldn't open… It needs to be simpler.*" Table 8 presents the categories related to instructional design expectations.

Table 8 Categories related to the theme 'Instructional design expectations'.

THEME	CATEGORY	F	DETAILS AND SOURCES
Instructional design expectations	Demand for past exam questions and mock tests	12	Need for independent practice; accessible question banks (L13, L15).
	Overcoming PDF conversion difficulties	8	Inaccessibility of PDF-based materials (L13, L15).
	Interface simplicity and access speed	6	Simple interface; fast access; seamless integration (L5, L16).
	Linguistic improvements (pronunciation/stress)	5	Stress/intonation issues; need for natural pronunciation (L4, L13).

DISCUSSION

This study examined how learners with visual impairments use AI-assisted audio content in an ODL context and their experiences and interaction patterns. The findings indicate that these technologies should be considered not only as tools for technical access but also as holistic learning components with pedagogical, cognitive, and affective dimensions. This broader role becomes especially important when considering the changing ways in which auditory learning materials can be produced. Previously, audio learning materials could either be produced through lengthy, fully human-centred production processes or assisted mechanically through computer-assisted means. However, innovations in AI-based technologies in the domain of voice production (Inamdar et al., 2023) and advances in voice synthesis technologies (Kane et al., 2024) suggest that AI-based instructor voices that more closely approximate human speech may foster stronger perceptions of credibility and social presence (Kim et al., 2022). For learners with visual impairments, who are among the most likely to benefit from this domain, there is a need to reconsider the production process for audio content (Elshaer et al., 2025).

Although digital platforms through which learning environments and content are delivered are viewed as a fundamental and indispensable learning ecosystem for learners, the provision of environments and content to learners with visual impairments does not necessarily mean that they can always benefit from them independently (Guddad, 2025). In this respect, AI systems with the capacity to recognise objects and read text without human intervention reduce learners' dependence on others and strengthen perceived academic autonomy (Koranteng, 2025; Yang & Taele, 2025). This is consistent with Marquez-Carpintero et al. (2025), who emphasize that AI significantly reduces the dependence of learners with visual impairments on sighted individuals. From this perspective, AI-assisted audio production becomes particularly important, as it can contribute not only to more accessible learning experiences for students with visual impairments but also to faster, scalable production of instructional audio, especially in institutions with limited time, workforce, and technical resources.

Most learners evaluated AI-assisted audio content not only as a technical tool but also as a means of social liberation that reinforces the feeling of not needing anyone and of being self-sufficient. This parallels the notion of a 24/7 accessible, non-judgemental assistant highlighted by Mukhtar et al. (2025). The autonomous learning experience emphasized by Yang and Taele (2025) also was evident in this study through learners' feelings of self-sufficiency. This indicates that AI can influence not only access to information but also academic self-efficacy and autonomy.

Voice gender preferences appear to be relevant for both human and AI-assisted voices In the study by Pias et al. (2024), a middle-aged male voice was perceived as authoritative, whereas a young female voice was perceived as warmer. This is consistent with the present findings: some learners described the female voice as softer and more fluent, whereas others reported perceiving the male voice as more reassuring or clearer. This finding can also be interpreted through Multimedia Learning Theory, particularly the personalization and voice principles, which suggest that human-like and socially engaging voices can enhance learner engagement and perceived connection. However, the variability in preferences observed here indicates that these principles may operate differently for learners with visual impairments, where intelligibility and cognitive comfort may outweigh social cues. Indeed, voice preferences were more closely related to technical quality and affective trust than to biological sex. In this regard, findings from Pi et al. (2022) suggested that the human voice creates a stronger sense of social presence, whereas AI voices can achieve comparable success in learning outcomes. Learners' preference for a single voice reflects a search for ways to prevent distraction and maintain auditory consistency. At the same time, the literature includes findings that using different voices for different subtopics can reduce cognitive load. For learners with visual impairments, the literature suggests that the perceived quality of a voice is often linked more closely to intelligibility, naturalness, familiarity, and ease of listening than to voice gender alone (Papadopoulos et al., 2009; Pucher et al., 2017). This suggests that instructional designers need to strike a fine balance between uniformity and variety and, where feasible, offer learners options.

Learners' perceptions of the AI-assisted voice reveal a tension between mechanicalness and functionality. While some learners responded positively to AI-assisted voices that can imitate human speech (Leong et al., 2023), others reported headaches and mental fatigue during long listening sessions due to monotonous voices. This is broadly consistent with research on learners with visual impairments showing that natural speech is generally perceived as more intelligible and comprehensible than synthetic speech, even though experience with text-to-speech may improve users' ability to process synthetic voices (Papadopoulos et al., 2009; Papadopoulos et al., 2010; Walczak & Fryer, 2018). This supports the view by Mogali et al. (2024) that monotonous artificial voices can increase cognitive load. Conversely, some learners reported that a mechanical voice increased attention and improved focus. This adds a different perspective to the general view in the literature that mechanicalness is a disadvantage. Despite the ideal of a perfectly natural voice noted by Filipova (2025) and others, mechanicalness in learners' interactions with this technology can function both as a source of cognitive load and, ironically, as a strategic tool that keeps attention alive. In this sense, AI voice is not merely a technical tool but a design element that directly affects learners' cognitive capacity. For learners with visual impairments, these findings suggest that mechanicalness should not be treated as a uniformly negative quality. Rather, because spoken delivery constitutes an important access route to instructional content, the design of AI voice can directly influence listening effort, user preference, and the overall usability of learning materials.

Learners' active use of features such as speed adjustment, rewinding/fast-forwarding, and pausing aligns with the literature suggesting that personalizable learning environments support self-regulation processes (Almufareh et al., 2024). Similarly, listening to content by dividing it into sections aligns with Mayer's (2020) Segmenting Principle in Multimedia Learning Theory, which posits that learners learn more effectively when information is presented at their own pace and in meaningful chunks. Presenting long, uninterrupted content via only the auditory channel can overload a learner's short-term memory capacity. Mental fatigue resulting from extensive, monotonous narration indicates that delivering information in units that learners cannot manage increases their overall cognitive load. This underscores the pedagogical importance of designing AI-assisted audio content as shorter, structured, and controllable segments. From a theoretical perspective, these findings resonate with Self-Regulated Learning frameworks (Zimmerman, 2002), which emphasize learners' capacity to manage their own learning processes through autonomy, control, and strategic engagement. At the same time, the reduction of dependency on others reflects the principles of Universal Design for Learning, particularly the provision of flexible and accessible learning pathways that accommodate diverse learner needs. Overall, the findings of the study can also be more explicitly situated within both Multimedia Learning Theory (Mayer, 2020) and Cognitive Load Theory (Sweller, 2005). Mayer's segmentation principle suggests that breaking content into manageable units reduces processing demands, while Cognitive Load Theory explains this effect through the reduction of intrinsic and extraneous load on working memory. The learners' preference for shorter, controllable segments, therefore, reflects an alignment between instructional design and cognitive architecture.

The technical features of speed control and pause/rewind are prominent tools that learners use to balance cognitive load. This is consistent with research showing that people with visual impairments actively adapt speech rate to improve usability and processing efficiency and often develop preferences for faster listening rates over time (Bragg et al., 2021; Choi et al., 2020). Learners consciously activate options such as speeding up, slowing down, or pausing to break the monotony and maintain attention. These practices show that the cognitive process is actively regulated rather than being a passive listening experience. Speeding up is used not only for time saving but also to alter the uniform flow, keep attention alive, and align the rhythm of mental processing with personal capacity. In this way, the learner restructures the listening process according to their cognitive processing speed. This suggests that not only the production process of content but also its delivery characteristics need to be considered, and that content can be used more efficiently with effective control mechanisms.

Learners' expectations suggest that the technology should be designed not only as a reading tool but as a learning partner. In this regard, the literature notes that AI support can enable learners with visual impairments to experience more autonomous learning without dependence on others (Sabzalieva & Valentini, 2023; Tsouktakou et al., 2024; Filipova, 2025; Yang & Taele, 2025). Demands for voicing assessment materials (past exam questions, mock tests) indicate that accessibility work should extend beyond instructional explanations. This redirects the emphasis on autonomy gains highlighted in recent studies (Adnin & Das, 2024; Sharma et al., 2025; Flores-Saviaga et al., 2025) to a practical application domain: functional voicing of questions. In addition, user-experience factors such as interface simplicity and technical speed are also seen as decisive in system design.

LIMITATIONS AND FUTURE RESEARCH

This study should be considered within certain limitations. First, the research focuses on the subjective experiences of learners with visual impairments regarding AI-assisted audio content. Therefore, the results are based on learner narratives and are not supported by objective performance indicators or quantitative data sources; this may limit interpretations to experience-based accounts. In addition, the research was conducted within a specific time period, and participants' experiences reflect conditions specific to that period; perceptions, attitudes, and usage practices that may change over time may fall outside this scope. Furthermore, the AI-assisted narration examples used were limited to a small set of content and specific voicing styles. Accordingly, learner experiences were shaped within the context of particular content types and voice characteristics, and potential diversity of experiences arising from different subject areas, content formats, or alternative voicing approaches may be outside the scope. In light of these limitations, future research is recommended to include quantitative performance data, conduct longer-term observations, and use broader sets of materials that encompassing different content types and voicing modes.

Future research should investigate how AI-assisted audio design features, such as voice characteristics, naturalness, and mechanicalness, affect learners' cognitive status, attention, and learning outcomes, particularly through experimental and longitudinal studies. In addition, more work is needed to examine how control features (e.g., speed adjustment, segmentation, and navigation) support self-regulated learning and metacognitive engagement over time. Expanding the scope beyond instructional content, future studies should also explore the accessibility and effectiveness of audio-based assessment formats for learners with visual impairments. Finally, adopting inclusive design perspectives, such as Universal Design for Learning, in the systematic development and evaluation of AI-supported learning environments would provide valuable insights into how to better accommodate learner variability and enhance equitable access.

CONCLUSION AND IMPLICATIONS

This study examined the experiences of learners with visual impairments with AI-assisted audio content in ODL environments and identified key findings regarding accessibility, learning experience, and technological design. The findings show that audio content is not merely an alternative learning tool for this learner group but a fundamental component of participation in the learning process. AI-assisted narration technologies enable learners to sustain academic activities independently, strengthening feelings of self-sufficiency and self-efficacy and supporting autonomy in learning processes. This indicates that accessibility is not only a technical adjustment but also a pedagogical necessity that strengthens participation in learning and a sense of academic belonging.

The study indicates that perceptions of AI-assisted narrations are shaped within a tension between mechanicalness and functionality. Although learners see AI voices as easier to understand and superior in quality compared to traditional screen readers, they frequently characterize them as lacking emotion and mechanistic. Nevertheless, some learners evaluate this mechanical structure as a functional feature that prevents distraction and supports cognitive focus. This finding points to the need for a balanced design approach between auditory naturalness and cognitive efficiency.

Cognitive load management is another prominent dimension of the study. Long, monotonous narrations can lead to mental fatigue and physical discomfort. Conversely, learners actively use technological features such as adjusting playback speed, pausing, and listening to content in parts as active learning strategies. This shows that technological features not only provide accessibility but also function as tools that support self-regulated learning processes. Findings regarding voice preferences suggest that rather than a gender-based superiority, technical and affective factors such as individual habits, perceived clarity, and sense of trust are decisive.

Based on the findings, several pedagogical and technical recommendations can be developed for the design of AI-assisted audio content. First, to reduce cognitive load, audio content should be presented in short, manageable segments rather than long, uninterrupted recordings, in line with Mayer's (2020) segmentation principle. In addition, improving Turkish stress, intonation, and pausing aligned with punctuation can increase the perceived naturalness of the speech and support comprehension processes. To enhance accessibility, it is essential to ensure that both instructional explanations and assessment resources, including past exam questions and mock tests, which are often provided in inaccessible PDF format, are also made accessible via AI-assisted narration. Technically, ensuring the full integration of audio content with learning management systems and mobile applications is essential for seamless and fast access. Simplifying interface designs and eliminating technical glitches will improve the learning experience for learners with visual impairments. Moreover, making options such as speech speed, intonation, and voice characteristics personalizable can increase learning efficiency by aligning with learners' individual learning rhythms. Developing AI-assisted audio content through a holistic approach that integrates accessibility, pedagogical design, and user experience can help create inclusive and sustainable ODL content (Ucar et al., 2026).

DATA ACCESSIBILITY STATEMENT

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

SUSTAINABLE DEVELOPMENT GOALS (SDGs)

This study is linked to the following SDG(s): Quality education (SDG 4) and Reduced inequalities (SDG 10).

ETHICS AND CONSENT

The research process strictly adhered to scientific research and publication ethics guidelines. The necessary legal permissions for the study were obtained from the Anadolu University Ethics Committee on May 8, 2025, with protocol number 878479. Considering the special circumstances of learners with visual impairments, the consent process was managed with an inclusive approach; information texts were conveyed verbally, and verbal consent was obtained. To protect the privacy of the learners and ensure the confidentiality of the data, their identity information was kept strictly confidential, and the raw data was not shared with third parties other than the researchers. The research did not contain any elements that would put the physical or psychological well-being of the learners at risk; the principle of voluntariness was adopted as a fundamental principle at every stage of the process.

COMPETING INTERESTS

The authors have no competing interests to declare. The fifth author served as an editorial board member previously.

AUTHOR CONTRIBUTIONS (CRediT)

Seçil Kaya Gülen: Conceptualization, data curation, writing—original draft preparation; Nedime Selin Çöpgeven: Conceptualization, data curation, writing—original draft preparation; Gamze Tuna Büyükköse: Conceptualization, data curation, writing—original draft preparation, methodology; Erdem Erdoğdu: Data curation, writing—original draft preparation; Hasan Uçar: Methodology, writing—original draft preparation; Mesut Aydemir: Writing—original draft preparation; Mustafa Doğuş: Reviewing, copy-editing, refining language, and providing comments and suggestions; Süleyman Arı: Reviewing, copy-editing, refining language, and providing comments and suggestions. All authors have read and agreed to the published version of the manuscript.

AUTHOR NOTES

Based on *Academic Integrity and Transparency in AI-assisted Research and Specification Framework* (Bozkurt, 2024), authors of this paper were reviewed, edited, and refined with the assistance of Gemini (Version by March 2026), complementing the human editorial process. The human authors critically assessed and validated the content to maintain academic rigor. The content was primarily translated by human translators, and DeepL (Version by March 2026) used for verification. Human translators then reviewed and approved the translations. The authors also assessed and addressed potential biases inherent in the AI-generated content. The final version of the paper is the sole responsibility of the human authors.

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