From Struggles to Strengths: Exploring How AI-Powered Assistive Tools Shape Inclusive and Accessible Learning

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Abstract

Education is constantly changing and evolving, causing new obstacles for those with learning difficulties to receive the right support and access to inclusive learning. Artificial Intelligence, as the basis for AI-powered assistive tools for learning, has received attention as a promising solution by offering personalized and real-time solutions that support user needs. This study addresses, in an exploratory way, how AI-powered assistive tools support individuals with learning difficulties by impacting accessible and inclusive learning. Through qualitative research with semi-structured interviews, twelve participants shared their experiences with AI assistive tools for learning in different real-life contexts. A thematic analysis was applied, showing how AI-powered assistive tools empowered the participants in different areas such as user motivation, perceived usability and user experience, and accessibility as well as inclusivity. The tools boosted confidence and offered personalized and adaptive learning strategies during high-pressure contexts such as exams and deadlines. Popular tools like ChatGPT, Grammarly, and Natural Reader are appreciated for their ease of use and diverse functionalities, although they show usability barriers, transparency concerns, and unequal access, leading to frustration. While the findings suggest that personalization of the tools and learning support led to accessibility and inclusivity improvements, barriers in user experience, usability, and equal access need to be considered to improve this effect. This study contributes to theory by adding a user-focused approach and widening the landscape of *how* and *why* users interact with technology, emphasizing the need for user-centered design of AI tools that improves equal access.

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1. Introduction

In today's digital world, humans are relying more and more on AI-powered technologies to support them with various tasks. Especially in recent years, AI-powered assistive tools have shown their potential for education and learning, supporting individuals with diverse learning difficulties. Individuals with learning difficulties often face a wide range of issues that can influence their level of concentration, information processing, and memory (Vidyadharan & Tharayil, 2019). Thus, they are left feeling a lack of empowerment and motivation, showcasing the effects on their self-esteem (Bhakiyasri, 2024). As stated by Bhakiyasri (2024), in these cases, AI-powered assistive tools aim to provide support and personalized learning for those struggling to achieve their academic goals and create a more inclusive as well as accessible learning environment.

Individuals who experience difficulties in learning oftentimes have a history of Neurodevelopmental Disorders (NDDs), which differ from temporary learning problems. To illustrate, NDDs are a category of disorders that includes specific learning disorders (SLDs) such as dyslexia and dyscalculia, as well as the widely spread Attention Deficit Hyperactivity Disorder (ADHD) (Jamil et al., 2023). As a result of NDDs, individuals experience an impact on their ability to learn and their academic achievements. However, for consistency and a universal understanding, these conditions combined with temporary struggles will be collectively referred to as 'learning difficulties' throughout this report.

Particularly, when it comes to success during their academic journeys and the process of 'life-long learning', individuals with learning difficulties face challenges. Nonetheless, this is where AI-powered assistive tools step in. AI-powered assistive tools are based on machine learning, which enables them to learn from previous interactions (Chopra et al., 2024). This process can be of great value for education and learning since AI-powered assistive tools can adapt to each individual's learning progress. For instance, tools can include chatbots such as

ChatGPT, intelligent tutors such as Duolingo, and text-to-speech tools for reading difficulties and enhanced concentration (Moraiti & Drigas, 2023; Wodzak, 2024). There is a wide variety of AI-powered assistive tools available to users, tackling individual challenges and learning difficulties.

While AI-powered assistive tools seem to be promising as a supportive technology, their true effectiveness in making learning more inclusive and accessible is still questioned. Especially in the long run, the benefits of AI-powered technologies are uncertain due to a lack of empirical studies and human-centered research (Stephanidis, 2023). Furthermore, gaps in current research are uncovered in the field of user motivation, usability, user experience, specific usage patterns of individuals with learning difficulties, and in the variety of learning difficulties. These scientific gaps are considered in the focus areas of this study.

It is important to analyze the opportunities that AI-powered assistive tools offer to support those struggling with learning difficulties and to see how they enhance inclusive along with accessible education. Even more so, it is necessary to focus on the individual needs of the user, to develop and improve the usability of AI-powered assistive tools over time (Eziamaka et al., 2024). Acknowledging *how* and *why* individuals with learning difficulties use AI-assistive tools is essential for further research into AI for education and its development. Furthermore, understanding the ways users interact with intelligent assistive tools can play a significant part in empowering other individuals with learning difficulties, and helping them recognize their potential (Bhakiyasri, 2024). By uncovering how AI-assistive tools are used today, doors will be opened for policymakers and educators, finding new ways in which AI-powered assistive tools can be implemented in education, especially for learners with special needs.

The focus areas of this study consist of the usage, user motivation, perceived usability, and the impact of AI-powered assistive tools on accessible and inclusive education. These

topics will allow us to explore the benefits and limitations of AI-powered assistive tools, via a user-focused approach. In this report, the following main research question will be addressed:

RQ: To what extent do AI-powered assistive tools make learning more accessible and inclusive for individuals with learning difficulties?

In this context, accessibility and inclusivity refer to the individuals' chances to participate in educational activities, learning independence, and access to new ways of learning. The following chapter will discuss an extensive theoretical framework of existing research in the field of AI-powered assistive tools and education. Furthermore, this study will apply a qualitative approach that gathers in-depth insights from users with learning difficulties, as closely described in the method chapter. Lastly, the findings obtained during the interviews will be analyzed and portrayed in the results and discussion chapters.

2. Supporting Individuals with Learning Difficulties: Theoretical Perspectives on AI-Powered Assistive Tools

This theoretical framework discusses the key themes as presented in the introduction, such as definitions of learning difficulties, AI-powered assistive tools for learning, concepts of user motivation, usability, and user experience, as well as the impact of AI-powered assistive tools on accessible and inclusive education.

2.1 Learning Difficulties and Their Impact on Academic Performance

Understanding individuals with learning difficulties requires a deep dive into their struggles to meet academic goals as well as the essence of these difficulties. Individuals whose ability to learn has been affected, often linked to a history of neurodevelopmental disorders, face diverse struggles related to information processing, acquiring information, concentration, and memory (Jamil et al., 2023). Acknowledging the characteristics of learning difficulties is crucial for analyzing the role that AI-assistive tools can have in supporting individuals and making their environment more inclusive and accessible for learning.

Individuals who experience learning difficulties in their academic journey or their career, do not only face temporary learning problems based on diverse circumstances – they can be affected by Neurodevelopmental Disorders. In this context, Specific Learning Disorders (SLDs) sum up disorders such as dyslexia and dyscalculia, which are known to affect academic skills, especially reading, writing, and mathematics (Jamil et al., 2023; Vidyadharan & Tharayil, 2019). These difficulties can impact individuals' academic journeys from a young age.

Furthermore, NDDs refer to disorders related to attention and the ability to concentrate, also known as Attention Deficit Hyperactivity Disorder (ADHD) (Gorai, 2024). According to Gorai (2024), individuals who experience symptoms of ADHD can lose their

ability to focus, while also being impulsive to a certain extent. In the case of ADHD, it is especially important to mention that for adults, receiving a diagnosis for this condition is extremely challenging, oftentimes leading to unmanaged and overlooked symptoms (Gorai, 2024). To a great degree, these difficulties can lead to a lack of motivation for achieving academic goals.

Lastly, NDDs include disorders that relate to the individual's ability to process information. Some disorders that impact information processing include Auditory Processing Disorders (APDs), Visual Processing Disorders (VPDs), as well as Sensory Processing Disorders (SPDs) (Krüger et al., 2001). According to this study, these are conditions that impact the brain's ability to process information that is received through senses such as hearing, vision, and multisensory input, resulting in deficits. Thus, affected individuals face difficulties when acquiring new information, resulting in a slower learning process. Having made these distinctions between different causes for learning difficulties besides temporary struggles, diverse types of needs can be uncovered for learners who might benefit from AI-powered assistive tools.

Individuals who face learning difficulties based on temporary struggles or NDDs are often unable to achieve their academic goals or receive the type of educational support that they need. This means that learners can face barriers, for instance, reduced academic performance, lower self-esteem and demotivation, as well as insufficient access to appropriate learning strategies (Bhakiyasri, 2024). As an example, struggles with mathematics due to dyscalculia might lead to low grades and difficulty keeping up with the class (Fenjuan & Jamaludin, 2023). Moreover, this article describes how continuous difficulties with learning will lower an individual's self-esteem and may result in anxiety and frustration. Modern educational systems that employ a standardized approach, only offer

support to a limited extent, leading to exclusion (Bhakiyasri, 2024). Consequently, many face hurdles regarding equal education.

The history of support for individuals with learning difficulties shows which traditional support systems have been used to eliminate exclusion in academic environments. Current approaches used to support learning difficulties in education include one-on-one tutoring methods, assistive technologies such as software, and classroom accommodations such as additional examination time (Bhakiyasri, 2024). These methods are successful to a certain extent; nonetheless, there is room for improvement. In comparison to traditional assistive methods for education, AI-powered assistive tools provide room for personalized learning materials, as well as adaptive learning solutions that address the above-listed challenges faced by individuals with learning difficulties. The next section will explore the meaning of these tools and how they work in the field of education.

2.2 AI-Powered Assistive Tools in Education: Roles and Definitions

Recently, AI-powered assistive tools have been discovered as tools to support individuals with learning difficulties. These tools focus on creating personalized education that is seemingly more accessible than ever before, not only in academic environments but also from home (Chopra et al., 2024). More and more applications for learning integrate Artificial Intelligence (AI) and Machine Learning (ML) models into their software, providing targeted support to learners. These tools are constructed to adapt to user needs, supporting them in areas such as comprehension, reading, writing, and memorizing (Panjwani-Charania & Zhai, 2023). Through the power of ML technology, AI-powered assistive tools can learn from previous inputs, making interactions with the tools personalized, leading to the identification of specific learning patterns (Chopra et al., 2024). By implementing a personalized approach, learners with special needs can benefit and experience more inclusive education.

AI-powered assistive tools have been blossoming over recent years, integrating intelligent systems, and allowing them to analyze user behavior through inputs and outputs (Chopra et al., 2024). This gives them the ability to provide personalized support, unlike traditional assistive technologies for learning. Moreover, AI-powered assistive tools have the potential to dynamically adapt to specific situations and the individual needs of a learner who faces difficulties (Papalexandratou & Stathopoulou, 2024). AI-powered solutions for learning are becoming increasingly relevant since they show potential in establishing a more inclusive environment with better access to learning.

Current research shows various examples of AI-powered assistive tools that are designed for learning. Some of the most common tools in the field of education include speech-to-text or text-to-speech, AI-powered assistants for writing skills, intelligent tutors, AI-powered chatbots, AI-based summarization, and note-taking tools (Habib et al., 2022). To create a deeper understanding of these tools, they will be presented according to existing literature.

Speech-to-text or text-to-speech tools are software made to support students with NDDs such as dyslexia, or difficulties with reading, making it more complicated for them to write full sentences and take notes from learning material (Habib et al., 2022). Referring to this research, speech-to-text tools can be AI-based applications that convert spoken language and audio material into text, assisting individuals with notetaking and writing. A well-known speech-to-text tool is Google Live Transcribe, which directly transforms audio into written text (Research Google Blog, n.d). By providing clear transcriptions, tools such as Google Live Transcribe open a world of possibilities for those finding it difficult to focus on notetaking.

On the other hand, text-to-speech is an AI-based tool that enables individuals to improve comprehension and concentration on long articles, by turning printed text into audio

(Habib et al., 2022). An example of a text-to-speech tool is Natural Reader, which uses artificial voices that read written text out loud (*AI Voices- Natural Reader Home,* n.d). Speech-to-text and text-to-speech tools open numerous possibilities for learners with special needs, mainly by reducing cognitive load and by helping users stay task-focused (Wood et al., 2017). Therefore, individuals can retain the information they need without unwanted distractions.

Furthermore, AI-powered assistants for writing skills further support the needs of individuals with NDDs such as dyslexia. These tools aim to provide real-time feedback on written text, giving information on grammar, spelling, and even helping to understand a foreign language (Fitria, 2021). Fitria (2021), describes tools that enhance individuals' writing skills, such as Grammarly and QuillBot. Thus, individuals who find it difficult to learn sentence structures and grammatical constructs can be assisted with tools like these, making immediate feedback possible.

For individual support at home, intelligent tutoring systems have become important over the past few years. Applications for learning slowly turned into AI-powered tutoring platforms that adapt to the individual needs of the user, considering their learning pace, style, and cognitive abilities (Wang, 2024). As an example for intelligent tutors, this research mentions Duolingo for language studies, which makes use of smart ML systems for personalized training based on individual performance. Therefore, individuals with learning difficulties can focus on themselves and their learning progress, working towards academic goals.

Lastly, AI-based summarization and note-taking tools focus on guiding individuals to process large amounts of information such as academic articles. Individuals who struggle with attention difficulties such as ADHD might experience difficulties concentrating on extensive amounts of information, which calls for summarized key points or concise

paragraphs (Jamil et al., 2023). Summarization tools based on AI, such as QuillBot and AI chatbots, format long articles into bullet points or summarized paragraphs, allowing individuals with attention difficulties to process academic articles (Kavanagh, 2022). This supports users to focus longer while processing larger amounts of information at a time. To highlight, the above-listed AI-powered assistive tools can be applied to different types of learning difficulties among different individuals, due to their ability to make education personalized and more inclusive.

Although AI-powered assistive tools aim to support individuals with learning difficulties, it is important to explain how these tools are not meant to replace crucial skills. Tools such as intelligent tutors are developed to strengthen the skills of individuals with learning difficulties, offering guidance for difficult assignments without handing them direct solutions (Panjwani-Charania & Zhai, 2023). This shows how AI can take on a supportive role without conflicting with the user's independence.

Moreover, existing research underlines various functions of AI-powered assistive tools that contribute to personalized learning. Their ability to create a personalized learning environment distinguishes them from traditional assistive tools that apply a one-size-fits-all technique to support individuals with learning difficulties. In this context, the most prominent functions revolve around analyzing user behavior, providing real-time feedback, and the use of predictive analytics to create exercises (Habib, 2022). To unfold, analyzing user behavior is essential to create personalized levels of difficulty and create recommendations for further learning processes (Bhakiyasri, 2024). Furthermore, providing real-time feedback allows for immediate error corrections and effective learning (Bhakiyasri, 2024). Lastly, predictive analysis leads to a quicker generation of new exercises that consider the strengths and weaknesses of the user (Barua et al., 2022). These functions contribute to an ongoing cycle of learning from user interactions.

Regardless of the steadily growing amount of research that is being conducted in the field of AI-powered assistive tools for learning, there is a clear gap in user-focused studies that acknowledge how individuals with learning difficulties implement these tools in a real-life setting (Stephanidis, 2023). Existing studies, largely focus on the theoretical aspects of AI-powered assistive tools and their benefits, neglecting true user interactions with technology. Therefore, this study aims to apply a user-focused approach to explore *how* and *when* individuals with learning difficulties rely on AI-powered assistive tools, resulting in findings that can contribute to creating user-friendly technologies. The following sub-research question aims to bridge these gaps: *How do individuals with learning difficulties use AI-powered assistive tools to enhance their academic performance?*

This section discussed the crucial roles of AI-powered assistive tools in creating personalized learning content and supporting individuals with learning difficulties. The following section of this framework will link AI-powered assistive tools to the motivation of individuals with learning difficulties, creating a deeper understanding of user behavior.

2.3 Adoption and User Motivation of AI-Powered Assistive Tools

New technologies have always relied on user motivation and adoption to achieve their preferred effect; however, this is especially important when it comes to users with complex needs. To start off, the meaning of self-determination will be discussed. According to the Self-Determination Theory (STD), three pillars are needed to achieve user motivation and adoption of technology: autonomy, competence, and relatedness (Arokiyaswamy et al., 2024). This article shows that the needs of these three factors should be fulfilled to increase the individual's motivation. In this sense, autonomy relates to self-initiative, competence relates to the skill set, and relatedness describes relationships and deeper connection (Arokiyaswamy et al., 2024). In the following, the ability of AI-powered assistive tools to create a sense of user motivation will be analyzed according to these three pillars.

By offering functions such as real-time feedback and personalized learning, AI has developed the ability to nurture the above-stated pillars of self-determination. Notably, AI has a strong potential to foster individuals' needs for competence by evoking the feeling of enhanced skills and growing the sense of academic confidence (Alasgarova, & Rzayev, 2024). However, Alasgarova and Rzayev (2024) call upon academic misuse of AI-powered tools in education, warning about the challenges of AI, undermining autonomy and relatedness which might cause superficial learning. Thus, it becomes clear how AI-powered assistive tools can support the need for competence and cannot enhance autonomy and relatedness for the purpose of learning.

Connecting to these findings, another qualitative study was conducted to examine how generative AI impacts user needs for autonomy, competence, and relatedness. The study suggests that generative AI can foster needs for autonomy and competence through flexible use, personalized real-time feedback, and the creation of safe spaces for users (Du & Alm, 2024). However, the need for relatedness is only fulfilled to some extent, since not all individuals seem to experience a sense of connection and true human interaction when using generative AI for learning (Du & Alm, 2024).

Existing research in the field of user motivation of AI-powered assistive tools shows somewhat inconsistent findings, highlighting the need for further research during this report. Especially concerning autonomy, existing research does not yet agree on how the functions of AI-powered assistive tools support autonomy or neglect it in the learning process. It is noticeable how specific user motivation for AI-powered assistive tools remains uncertain, highlighting the need for further research. For this reason, the report addresses the following sub-research question, bridging gaps in current knowledge: *What motivates individuals with learning difficulties to use AI-powered assistive tools*?

Motivation is a critical factor leading to the adoption of AI-powered assistive tools among individuals with learning difficulties, as it impacts how individuals explore and adopt technologies into their daily routines. As stated in research, important factors that play a role in user motivation are autonomy, personalized content, and confidence boosters, which can lead to engagement with technologies. Moreover, the effectiveness and long-term adoption to support learning difficulties can depend on usability, user experience, and the implementation of human-centered design. These aspects will be examined in the following section.

2.4 Usability and User Experience: The Implementation of User-Centered Design

The overall effectiveness of AI-powered assistive tools is not only determined by the various functions of these tools but also by the usability and User Experience (UX). Usability is required for the user to flawlessly interact with the technology (Mayes & Fowler, 1999). Moreover, UX of technology refers to the broader experiences that are made while using it, such as emotional and cognitive responses that include satisfaction and frustration (Hassenzahl & Tractinsky, 2006). In this sense, UX takes a human perspective, connecting the individual with technology (Hassenzahl & Tractinsky, 2006). For the effectiveness of AI-powered assistive tools, they must include necessary factors relating to both usability and UX.

Various factors shape the usability and experience of an AI-assistive tool, creating a perception of user-friendliness and effectiveness in supporting learning difficulties. Some of those factors are user trust and transparency, user-centered design principles, as well as user comfort and expectations (Kumar & Burgavi, 2024; Usmani et al., 2023; Dave et al., 2023). To start, the foundation of enhanced UX relies on transparency, calling for clear explanations of how AI systems make decisions (Kumar & Bargavi, 2024). According to Kumar and Burgavi (2024), trust in AI tools is established over time through the design principles. Thus,

ensuring that transparency is established enhances trust and contributes to a positive experience for learners with special needs for support.

Moreover, human-centered AI according to user-centered design principles plays an important part in shaping user experience for learners. Especially AI-powered assistive tools meant to support learning difficulties should prioritize the empowerment of learners and the personalization of content to enhance UX (Usmani et al., 2023). Furthermore, the ability of AI-powered assistive tools to adapt to users and their skills often leads to enhanced usability and experience (Lee, 2024). Thus, it is of great importance to implement a user-centered design approach that involves the individual, ensuring that the technology will meet their needs (Eziamaka et al., 2024). As stated by Eziamaka et al. (2024), designing sophisticated AI tools alone is never enough, the user must always be kept in mind. This is especially important since learning difficulties are often complex.

Lastly, the UX and usability of AI-powered assistive tools are dependent on comfort and expectations. Compared to first-time users of AI-assistive tools, users with more experience tend to develop higher comfort levels as well as more realistic expectations when working with these tools (Dave et al., 2023). According to Dave et al. (2023), keeping this in mind during the design process will lead to enhanced usability for both first-time users and experienced users of AI-powered assistive technology.

The research stated above clearly examines the important factors that must be considered for user-friendly AI-powered assistive tools. However, no studies were found that investigate how individuals with learning difficulties perceive the current usability and UX of these types of technologies, therefore lacking an analysis of how well human-centered design principles are implemented. Without the focus on user experiences, AI-powered assistive tools might lack the ability to meet user needs and create an inclusive environment. For this

reason, this research includes the following sub-research question: *How do users of AI-powered assistive tools perceive their usability and overall user experience?*

Critically examining the factors of usability and UX is crucial when assessing the effectiveness of AI-powered assistive tools for individuals with learning difficulties, and their ability to enhance inclusive education. The final section aims to uncover how current research discusses the ways in which AI-powered assistive tools can impact accessible and inclusive education, especially for those with learning difficulties.

2.5 AI-Powered Assistive Tools for Accessible and Inclusive Learning

Learning environments strive to make education and new ways of learning more accessible and inclusive, especially for those with learning difficulties. Nevertheless, today's educational systems seem to neglect the individual needs of learners, creating barriers to achieving academic goals (Bhakiyasri, 2024). In this context, AI-powered assistive tools show their potential to create a more inclusive environment as well as more accessible education for individuals with learning difficulties, catering to their different needs with personalized content. Therefore, technology strives to remove barriers, creating a sense of independence, and leading to inclusive as well as accessible education.

With its functionalities and ability to provide personalized content, AI-powered assistive tools open doors to accessibility and inclusivity for learning. Habib et al. (2022) researched the revolutionizing ways in which AI-powered assistive tools can create inclusion through the adaptive learning process. According to Habib et al. (2022), AI's ability to analyze large sets of personal data at a time leads to information about the different learning styles of individuals with learning difficulties. Therefore, creating an inclusive learning environment that is tailored to user needs.

The above-mentioned examples of AI-powered assistive tools improve inclusion and accessible learning for different types of learning difficulties, breaking barriers to academic

success. Speech-to-text and text-to-speech tools make written content more accessible to those struggling with dyslexia or processing disorders (Habib et al., 2022). Furthermore, AI-powered assistants for writing skills enable academic writing, leading to inclusivity and new opportunities for individuals with learning difficulties (Fitria, 2021). Thus, AI technology which considers personal needs enhances the inclusivity levels in education.

In this context, AI tools can foster independent learning, making education widely accessible, even at home. AI-powered tutoring systems such as Duolingo provide a personalized environment that adjusts to individual needs without the need for in-person tutoring (Wang, 2024). Wang (2024), states how intelligent tutoring systems create a safe space for individuals with learning difficulties, allowing them to learn at their own pace, without experiencing pressure due to the presence of other individuals. This independent way of learning creates an inclusive environment that can be accessed anytime and anywhere.

However, next to the benefits of AI-powered assistive tools in this field, they also bring certain challenges when using them. Since AI-powered assistive tools are adaptive technologies, they are known to gather sensitive user data (Bhakiyasri, 2024). As stated by Bhakiyasri (2024), the issue of AI gathering personal data, by going against ethical and privacy regulations, hinders the effectiveness of AI-powered assistive tools for accessible and inclusive education. By considering privacy and ethical concerns, the true influence of these tools can be acknowledged.

So far, research has established the potential of AI-powered assistive tools to enhance accessible and inclusive learning. However, much of these studies focus on theoretical factors such as ML systems for personalized learning, rather than real-world experiences of users and their perception of the impact on accessibility within education and learning. Thus, this study targets noticeable gaps in qualitative research by placing user perspectives in the center and by addressing the following overarching research question: *To what extent do AI-powered*

assistive tools make learning more accessible and inclusive for individuals with learning difficulties?

By diving into this question, this study aims to bring about user-centered insights that can drive inclusivity and accessibility improvements in every educational context.

3. Methods

The following chapter includes sections that provide detailed insights into the general research design, the sample, data collection procedures, and the analysis of the raw data. To round off, information on the ethical considerations is provided.

3.1 Research Design

This user-focused study applied a qualitative research design to analyze the usage patterns, personal experiences, and motivations of individuals with learning difficulties who integrate AI-powered assistive tools into their daily lives. By employing qualitative research methods, a more nuanced understanding of user experiences was created, allowing participants to share personal thoughts, challenges, and perceived benefits of AI-powered assistive tools (Brotosaputro et al., 2024). Thus, the qualitative approach aligned with the exploratory objectives of this research, bridging gaps in current scientific studies.

In this study, a semi-structured interview approach was applied with open-ended questions. By creating a semi-structured interview guide, participants were free to share their experiences, without any restrictions created by the interview itself, while also allowing for appropriate follow-up questions (Brotosaputro et al., 2024). The chosen research design was essential when it comes to gathering accurate representations of the participants' experiences, creating a comprehensive overview of their usage, motivation, perceived usability, and sense of accessibility as well as inclusivity. The insights of this research design contributed to the overall objectives of this study: to advance knowledge based on true experiences, for the development and integration of AI-powered assistive tools for accessible learning and education.

3.2 Sample

To establish an appropriate sample, purposive sampling was employed. Purposive sampling ensured that only participants with relevant experiences were included in this research (Brotosaputro et al., 2024). To elaborate, the inclusion criteria for participants were based on both existing interactions with AI-powered assistive tools for learning, and on a history of learning difficulties due to either NDDs or temporary struggles. Thus, participants that did not meet these criteria were excluded from this research.

It is important to mention that this study did not exclusively focus on participants who have been diagnosed with an NDD. More importantly, this research laid its focus on diverse user needs, with or without diagnosis. Therefore, the interview guide did not explore any information that identifies the learning difficulty, keeping the focus on lived experiences. Additionally, snowball sampling was employed to reach more participants with valuable insights, meaning that participants were asked to refer any other potential participants.

The participants were recruited through the researcher's academic and personal network, considering the sensitive factors of this study when reaching out to individuals. The recruitment process included contacting potential participants through in-person contact and social media platforms, by briefly explaining the study. In total, a sample size of 12 participants was recruited, aged between 18 and 49, with occupations varying between high school students, university students, and corporate employees.

3.3 Instruments

The principal instrument applied in this research was the semi-structured interview guide, which was specifically developed for this study (view the Interview Guide in Appendix A). The guide aimed to explore the participants' personal experiences and usage patterns of AI-powered assistive tools for learning. Thus, the questions in the interview guide were established based on literature discussed in the theoretical framework, which focused on

perceived usability and user experience, user motivation, and the way accessible learning is impacted by AI-powered assistive tools.

Based on the established gaps in existing research, the questions were developed in line with the aim and sub-research questions of the study, resulting in the following thematic categories: an introduction, icebreakers, usage of AI-powered assistive tools, motivation to use AI-powered assistive tools, perceived usability, impact on accessible and inclusive learning, and a closing. The questions were phrased according to an open-ended structure, making them suitable for exploring individual experiences while not losing sight of the research objectives.

Since this is one of the first exploratory interview studies in this field, a pilot interview was conducted to ensure reliability and validity of the interview guide (Sampson, 2004). Input from a pilot participant, who was generally familiar with the topic, led to refinements that improved the structure and understanding of the instrument.

3.4 Procedure

The interviews took place in a neutral and informal setting with minimal distractions to allow the participant to entirely focus on the interview, while creating a safe space for sharing experiences. Before the start of the interview, the participant was given an information sheet and an informed consent sheet, explaining the purpose of the study, participant rights, and data handling (view the Information Sheet and Informed Consent in Appendix B).

The participant was given the opportunity to ask questions before signing the consent form, either physically or digitally. In total, eight of the interviews were conducted in-person, with four as a secure video call via Microsoft Teams. Based on the native language of the participant, the interview guide was translated into Dutch and German to create a more natural setting for the participant without language barriers.

To ensure accurate transcription, each interview was audio recorded. The interviews began with a short introduction to the study and relevant icebreaker questions to create a relaxed environment, after which they followed the same semi-structured interview guide. Each interview lasted between 35 and 50 minutes, (M = 40.6). Finally, the participants were thanked for their time asked if they had any further questions or if they would like to receive a summary of the results.

3.5 Analysis

This study implemented a thematic analysis that used a deductive and inductive coding method. This method to analyze qualitative interview data was conducted to allow for flexibility and free exploration of patterns and themes within the data, leading to insights that can be applied to the research objectives. A thematic analysis suits this qualitative research, especially since the objectives and research questions are exploratory. The qualitative research software – ATLAS.ti – was used to create the codebook, which considered the knowledge gained from the theoretical framework and the research questions. Therefore, deductive codes stem from current research, resulting in themes such as usage patterns, perceived usability, user experience, motivation, and impact on accessibility and inclusivity. However, this codebook was adapted inductively, throughout the coding process.

The first round of coding served as a pilot, which strengthens the reliability of the codebook. Transcripts were transferred into ATLAS.ti, as this software allows for organization of data and supports the coding process. After transferring the transcripts, a three-step coding process was applied, consisting of open coding, axial coding, and selective coding. Open coding was applied by reading through each transcript, marking all segments that included meaningful information, and labelling them with descriptive codes. During the axial coding phase, the focus lied on finding connections between the coded segments, which uncovered hidden patterns in the participants' experiences. Finally, selective coding was

applied, to build the narrative from the transcript data that related to the objectives of the study.

The coding process led to the finalized codebook used consistently throughout all transcripts (view the codebook and clarifications in Appendix C). After changing the codebook inductively, all transcripts were coded again to ensure consistency. A consistent coding process and reliable codebook were ensured through inter-coder agreement, meaning that a subset of the interview data was independently coded by a second researcher, using the same codebook. This inter-coder agreement was measured by a peer discussion about the coded transcript segments. The reliability and validity of the codebook were established by a high level of intercoder agreement, with only minor misalignments that were resolved through collaboratively discussing the codebook and further coding process.

3.6 Ethical Considerations

This study took ethical considerations into account, given the involvement of participants with learning difficulties and the possibility of sensitive topics. Therefore, several measures were taken, such as the inclusion of an informed consent that informed about the participants' rights, anonymity, handling of sensitive data, and compliance with the university guidelines. In addition, the informed consent stated the voluntary nature of this study, giving participants the right to skip questions and withdraw at any time.

All collected data was handled with strict confidentiality, meaning that no identities were revealed. This was done by assigning numbers to participants, resulting in participants 1 through 12. Furthermore, the transcripts and the report were anonymized, after which they were safely stored in the database of the University of Twente. Lastly, by receiving ethical approval for application nr. 250858 from the ethics committee, domain Humanities & Social Sciences of the Faculty of Behavioral, Management and Social Sciences at the University of Twente, this study ensures that all procedures are in line with the institutional guidelines.

4. Findings

The thematic experiences presented in the following sections are structured around the flow of the coding process and the study's sub-questions, resulting in a clear narrative of how diverse individuals engage with AI-powered assistive tools in their daily lives, across various learning contexts.

4.1 Usage Patterns and Learning Contexts for AI-Powered Assistive Tools

Since the sample included participants from both academic and professional settings, insights show a broad range of used AI-powered assistive tools for learning in different areas of their daily lives. The analysis of user behavior resulted in three thematic groups: context of use, frequency of use, and types of AI-powered assistive tools described in usage patterns.

4.1.1 Context of Use

An overwhelming majority of participants reported using AI-powered assistive tools to improve their learning process in an academic context. In total, 10 out of 12 participants stated that they frequently use AI-powered assistive tools such as ChatGPT, Grammarly, Natural Reader, and QuillBot to support them in the context of completing assignments, study planning or exam preparation, summarizing complex academic materials, and improving their writing skills. These patterns in user behavior occur both in a traditional classroom setting, as well as in more flexible settings such as during home study. Especially academic assignments related to technical and mathematical subjects, which often require concentration, problem-solving, and critical thinking, were highlighted often by participants as a trigger for tool use.

> *"In class, we're allowed to use AI for our assignments — especially in computer science, like when programming in Python, or for problem-solving in fields like bearings and connection technology."* – participant 1

This participant provides a concrete example of tool use in a classroom setting, largely for completing assignments in complex technical fields. Furthermore, academic assignments are described as being heavy in writing, including the need to draft extensive reports and browse through dense articles for deadlines and exam preparation.

> *"I mainly use tools like ChatGPT for making revisions or summaries. When I'm writing essays or preparing for exams, I usually ask it to create a summary for me."* – Participant 11

Here, clear support is provided for a reoccurring pattern that shows how students use AI-powered assistive tools to digest complex academic material with summaries, allowing them to improve writing and exam preparation. In addition to academic contexts, some participants mention improving their learning process in a professional setting – for example when drafting corporate emails and improving writing techniques.

> *"For example, when I write to a colleague from HQ who's known for being unresponsive. […] Then I run it through ChatGPT to make sure it's professional. Especially with higher-ups, I use it to double-check spelling and tone."* – Participant 7

This quotation underlines a real-world usage scenario, outside of a traditional academic context, while still clearly supporting learning and skill development. Lastly, a few participants showcase learning in an everyday setting, without clearly being related to academic or professional contexts. Particularly for supporting new skills such as language learning, participants highlight their use of tools such as Duolingo and DeepL.

4.1.2 Frequency of Use

The frequency of use varied across the sample, showing that most participants use AI-powered assistive tools several times a week. It was found that these patterns in use frequency clearly connect to episodic use, especially during high-pressure situations such as exam periods and crucial deadlines.

> *"Mostly during exam periods or when working on assignments. It really depends on what's going on at the time."* – Participant 1

Contrasting to this pattern, some participants shared insights towards their habitual use and implementation into their daily routines, although this has not been recognized as a universal pattern across all participants. Those who discovered AI-powered assistive tools as an effective support system showed more signs of frequent and everyday use to learn, maintain their study progress, and manage overwhelming situations.

> *"Almost daily, especially because of my thesis."* – Participant 6

These insights show how frequency is largely dependent on context, influenced by workload and personal need for learning support.

4.1.3 Tool Types and Ecosystems

To fit their individual needs and preferences, many participants have built a personal ecosystem with AI-powered assistive tools, showcasing their implementation for targeted support. The most common tool used by every participant, is ChatGPT. This tool is used for general support with learning, explaining complex concepts, and problem-solving. Some participants have described their use of Natural Reader, which is a common AI-based text-to-

speech tool. Natural Reader showed its use in text-to-speech conversion and to support not only reading skills but also to enhance concentration.

> "*For example, I used a tool called Natural Reader last year. I'd upload articles or long documents, and it would read them out loud to me."* – Participant 4

Furthermore, explicitly in the context of writing support, participants highlighted their use of Grammarly and QuillBot, which are both tools for grammar checking, paraphrasing, and work supportively for academic writing.

> *"I use QuillBot a lot for grammar corrections, and ChatGPT for pretty much everything"* – Participant 6

Next to writing support, tools such as Duolingo and DeepL are discussed by multiple participants to support with translations and language learning, often as an addition to other supportive tools. In the context of exam preparation and study planning, most tools emphasized by participants are ResearchRabbit, SciSpace, TickTick, and Quizlet. These tools are used for managing research and scientific articles, retrieving summaries, managing time and productivity effectively, and preparing for exams with quiz-style flashcards.

> *"I also had it create flashcards, which I imported into Quizlet. I love Quizlet's smart repetition system"* – Participant 4

> *"I use Research Rabbit — it helps me find related sources quickly, so I don't have to sift through everything myself."* – Participant 4

Based on OpenAI's model, some universities have adapted their own tools for student needs, mainly used for academic accuracy, literature searching, and citation features. Although interesting and crucial, this experience is limited to two participants.

> *"Examples would be ChatGPT, for instance. Our university has its own AI-supported learning tool that's based on ChatGPT"* – Participant 1

The variety in which different participants established their own personalized combinations of AI-powered assistive tools according to their user behavior and needs highlights how versatile usage patterns can be. The use of multiple tools to balance the limitations of only using a single tool shows flexibility and support in various contexts.

Altogether, these findings show that the participants implement and apply various AI-powered assistive tools for learning and to tackle their learning difficulties. Their user behavior is highly dependent on the context – for example task demands, individual preferences, and high-pressure situations from their environments. Usage is therefore clearly context sensitive, showing episodic use in academic settings, pointing towards user motivation and the need for autonomy in managing ones' learning process. The motivation behind these usage patterns will be discussed in the following section.

4.2 User Motivation: How AI-Powered Assistive Tools Keep Learners Engaged

Based on the coded data, user motivation is structured around the core themes of Self-Determination Theory, the participants initial motivation and sustained use, as well as possible experiences with decreased use. Further emotional context of user motivation was found in the data, completing the picture of user engagement.

4.2.1 Self-Determination Theory: Autonomy, Competence, and Relatedness

When it comes to the need for autonomy, participants showed different experiences with assistive AI and its ability to support autonomous learning behavior. These experiences varied between supporting and undermining the user's sense of autonomy, sometimes resulting in over-reliance on the tools ability to do the work for them, reducing the sense of self-achievement and agency in learning.

> *"Honestly, I think they just make students lazy. Especially now — with thesis writing and assignments […] I don't really understand what I'm doing. It's like letting the tool do all the work."* – Participant 5

However, next to the clear support for a loss of engagement and a lack of control over their learning process due to AI use, an almost equal number of participants experienced an increased sense of control. Multiple aspects were highlighted such as the ability of being able to decide how and when to use support, the ability to control both the input and output of AI, and the ability to use it in a flexible way, not as a replacement for self-learning.

> *"It doesn't replace self-learning, because you still have to understand and apply everything yourself. But it speeds up the process"* – Participant 1

> *"When I give very specific instructions, it feels like I'm still guiding the process, still thinking about it, even if I'm using AI as help."* – Participant 9

Thus, participants highlighted both benefits and limitations towards AI and autonomy support, with a few participants voicing ambivalent experiences, suggesting only partial support which depended heavily on the context. Different from autonomy, the need for

competence was showcased as a consistent experience during AI use. Most participants reported feeling more capable when using AI-powered assistive tools for learning, especially during complex tasks and assignments with which they struggle due to their learning difficulties. Many participants referred to AI-powered assistive tools as being *confidence boosters* due to their ability to offer step-by-step guidance and to stand by the user's side.

> *"They add structure and give me confidence, like having someone backing me up. It helps me feel like I understand things better."* – Participant 12

Making learning and assignments more manageable contributes to AI's ability to create a sense of confidence and progress in learning, as reported by the participants. The last pillar of the Self-Determination Theory, the need for relatedness, contrasts to both autonomy and competence in participant experiences. Feeling connected and emotionally understood by AI-powered assistive tools is not reflected by the data, showing how these tools are appreciated for their efficient tool-like nature but that they lack a human side.

> *"It's clearly a robot. Even if it mimics human language, it'll never be the same. I don't ask it personal things. I talk to it like a tool, not a friend."* – Participant 5

While participants still see the tool as useful, relatedness was not seen as a motivational driver for tool use. Among participants, AI-powered assistive tools were not described as a replacement for human connection.

4.2.2 Initial Motivation Vs. Sustained Use or Disengagement

When exploring the participants initial motivations to start their use of AI-powered assistive tools, the following drivers attracted attention: peer influence and the need for

support. In their personal stories about their first contact with these tools, friends and family often played a role as the source of their first introduction.

> *"I avoided all AI tools until my dad and brother, who are both into AI, encouraged me to give it a try."* – Participant 4

Other participants described their initial contact as being out of clear necessity, due to academic struggle and the need for support. In these cases, users have highlighted the use of AI support when traditional support or resources were lacking.

> *"At university there are just too many students per professor. So, you have to figure things out for yourself. And understanding the scripts and documents provided isn't always easy."* – Participant 1

Based on their initial motivation, the participants reported motivational drivers leading to sustained use and full adoption of the AI-powered assistive tools. Resulting from the analysis, the main drivers for sustained use are efficiency and gamified elements. In terms of efficiency, participants shared their experiences of being able to complete assessments faster without cognitive overload, as well as manage tasks more effortlessly.

> *"That's such a time-saver, especially when there's so much university work"* – Participant 11

Regarding gamified elements, some tools such as Duolingo include streaks and frequent reminders for repetition assignments. These elements are specifically described as

being motivating for everyday and sustained use, keeping the user *hooked* to learning. Although for most participants, first contact led to sustained use and adoption of AI-powered assistive tools, some participants shared their experiences towards disengagement. This form of demotivation was most observed due to a lack of support by the tools and a mismatch between the tool and the personal needs of the user.

> *"I'd already written the text and wanted to just check it, but it didn't suggest any useful improvements. It didn't help much."* – Participant 3

For some participants, experiences such as these cause a drop-off in their usage patterns and engagement with the tools. However, this pattern was not observed often and depends on the context of use.

4.2.3 Emotional Drivers

As an additional factor that significantly influences sustained use, emotional drivers were observed in participant experiences. The most crucial emotional motivator was the reduction of stress, especially in high-pressure situations which were already uncovered in usage patterns. Participants described a calming effect of having the additional support and assistance of AI systems.

> *"When I don't understand something, I feel stressed. But when ChatGPT helps me understand it, that stress is reduced."* – Participant 12

This emotional factor serves both as a motivational driver and coping-mechanism, leading to sustained use of AI-powered assistive tools for most participants who share this experience. To summarize, in the experiences shared by participants, motivations that drive

users to sustained use are clearly complex. While competence and relatedness find strong one-sided support in the data, autonomy is mixed, reflecting both benefits and concerns. Overall, initial exposure due to peer influence or the need for support mostly led to sustained use and adoption, although in some cases participants described a decrease in use for certain tools.

4.3 Estimating Usability and User Experience in Practice

This section explores perceived usability and user experience of AI-powered assistive tools by users with learning difficulties. The following section is structured around themes such as tool functionality and ease of use, usability barriers and technical problems, trust and skepticism, as well as the balance between satisfying experiences and frustrating ones in the context of learning.

4.3.1 Functionality and Ease of Use

Regarding tool usability, participants highlighted positive factors that hinted towards ease of use. This includes easy access to the tools, simplicity of tool use, and convenience, allowing users to reach their goals and reduce cognitive load.

> *"I prefer using ChatGPT because it's conversational and more user-friendly than Google. […] ChatGPT gives me a direct answer. Academically, it's similar—I ask a question, get a response"* – Participant 12

Many participants emphasized their appreciation of the tool's ability to simplify complex information and communicate in plain, user-friendly language that enhances understanding. In this sense, it became clear that users find the conversational Q&A style of

tools such as ChatGPT especially helpful to support deeper engagement with complex topics, breaking them down into manageable pieces.

> "*Then I asked it to explain everything in simple terms, like to a middle schooler. […] It made the process way more manageable*." - Participant 4

As an addition to the conversational style and plain language, other functional elements of AI were uncovered, such as the ability to generate ideas, personalize output, and offer guided problem solving. Functions such as these were highlighted by participants as effective in supporting them to reach their academic goals.

> *"Also, because it learns from what you feed it, it can give really personalized help."* – Participant 6

In terms of tool functionality and usability, some participants compared different tools to find the most fitting solution for their personal needs. For example, QuillBot and Grammarly might have similar functions, however, participants showed different perspectives and preferences on the tool's usability.

4.3.2 Usability Barriers and Challenges

Even though tool functionality and ease of use enhance user-friendliness and effective learning, some highlighted technical issues with AI-powered assistive tools create barriers and hinder both usability and user experience. Most participants reported technical problems related to AI output, seemingly unrelated to their input. These technical errors include incorrect, vague, and irrelevant responses leading to frustration over the tools incapability to offer precise support.

"Goodnotes can turn notes into flashcards — that works well when it's my own material, but it creates too many cards and splits info strangely." – Participant 3

Some stated clear technical errors that impact usability such as unexplained error messages that interrupt the user's workflow and reduced confidence in the tools ability to support the learning process.

"Sometimes you get error messages like "Oops, something went wrong."" – Participant 2

Although most participants gave a clear impression of being able to tolerate technical errors and challenges surrounding usability, some reported to have stopped using certain functions of the tools in use for this reason. Since most usability limitations clearly impact the ways that participants interact with AI-powered assistive tools, possible suggestions for improvements were explored closely. However, the results for these suggestions were vague, with most participants suggesting the desire for improved accuracy. Thus, the participants seemingly lacked ideas for improvements that would bridge barrier related gaps.

4.3.3 Trust and Skepticism

It was interesting to find that although many participants use AI tools for learning regularly, some even on a day-to-day basis, not one user has established a sense of trust in them. Thus, many rely on tool support but are critical when it comes to their output, especially for academic tasks.

"I don't trust it. If I ask it for sources, the links often don't work or lead to strange websites." – Participant 5

The theme of AI transparency is closely connected to the lacking levels of trust. In this sense, all participants agreed that AI seems to lack transparency in its communication, mainly when it comes to data usage and storage. This raises ethical concerns among participants about their privacy and data safety.

> *"But mainly, the privacy issue bugs me the most. Even if you switch off data sharing, you never know what's really being stored."* – Participant 2

Despite being critical towards trusting AI-powered assistive tools and their clear lack of transparency which both impact user experience and engagement, all participants choose to use AI as a supportive back up when there is no other help available.

> *"It's basically a support system when you don't have someone to ask, or when you want something explained in another way."* – Participant 1

Although, statements such as these clearly highlight comfort with AI support, participants maintain a preference of human interaction over AI when available.

4.3.4 Frustration Vs. Satisfaction

The user experience of the participants is mixed, marked by both satisfaction and frustration about tool use. It showed how users are satisfied with both the tools performance and its helpful functions. These elements of satisfaction were especially highlighted during moments of success while learning with AI-powered assistive tools.

"Because it just makes things so much easier. So, the usefulness in specific situations was huge. That was very helpful." – Participant 9

Contrasting to the satisfying experiences mentioned, almost every participant has hinted to frustrations they had encountered during the use of AI assistive tools. The most common frustrations were AI limitations in the field of answer accuracy, logical reasoning, and mathematics and a perceived lack of human touch and naturalness of the tool. Some participants also highlighted a steep learning curve in the initial phases of using AI tools for learning, especially when it comes to giving correct prompts and building towards personalization.

"I remember around a year ago, it was especially bad at math. So, in those cases, it wasn't useful at all." – Participant 11

The lacking ability of AI to provide correct answers and support users with mathematical assignments causes gaps in their user experience, especially for those desiring additional support for these types of areas.

"There's definitely a learning curve in the beginning. You need time to figure out how to ask the right questions, and the tool also needs time to "learn" how you communicate." – Participant 6

Here, the participant clearly described experiencing a rough start with AI usage, influencing their user experience but showing potential for improvement. The balance between satisfying experiences and frustrating ones shows how AI assistive tools both

support and limit the learning process of participants. Still, most participants continue their usage patterns because of usefulness but are cautious towards their expectations.

To conclude, tools are mostly perceived as helpful due to ease of use and functions such as personalization and conversational language, which contribute to an effective learning experience. However, technical challenges such as output errors, a lack of trust, and frustrating experiences with AI's limitations caused a mixed user experience among participants. Therefore, AI was viewed as an additional support system to human interactions, being practical and efficient, yet imperfect.

4.4 Learner Perspectives on Accessibility and Inclusivity

This final section explores nuances in participant experiences on how AI-powered assistive tools add to accessible and inclusive learning for individuals with learning difficulties. Most participants highlighted their positive experiences towards accessibility and inclusivity improvements, benefiting them in terms of new learning strategies and resources, as well as participation. However, contrasting perspectives are mentioned that underline technological and financial barriers, which hinder AI's ability to positively impact accessibility and inclusivity.

4.4.1 Accessibility Improvements

Across interviews, participants have shared how AI-powered assistive tools have increased their access to new ways of learning as well as new learning material that differs from traditional resources. Especially conversational AI such as ChatGPT is highlighted as a tool to change the ways in which individuals learn, such as being able to constantly ask questions without fear of judgement, finding new ways to prepare for exams, and creating personal learning strategies to fit individual needs.

"They let you ask questions outside of what's written in the lecture notes […] With AI, you can dig deeper — ask for clarification, which makes it easier to understand things outside of class." – Participant 1

"I also ask it to present information in a story-like way, which works much better for me than bullet points or raw facts." – Participant 4

While being less clear in participant experiences than access to learning strategies, access to learning materials has also improved to some extent. This mainly includes access to academic articles through supportive tools such as SciSpace and ResearchRabbit, as well as access to digital learning resources through intelligent tutors such as Duolingo.

"it's an app that you always have with you, and it's not a book. So, material-wise, it's not a book or a CD, it's just an app that you always carry and can use at any time." – Participant 8

Within the theme of accessibility and inclusivity, participants disclosed experiences towards individual learning support, which they can receive from AI. Most commonly, participants underlined deeper understanding of complex concepts and being able to regain concentration. In comparison to tradtional support systems, AI-powered assistive tools were able to close gaps that could not be closed before.

"I give it long texts. That I wouldn't really be able to read through and actually absorb the information. […]. More of it sticks, I learn better through summaries." - participant 10

To expand on this, many have explained their appreciation of personalized learning support, showing how AI learns from input over time, uncovering individual preferences and needs. Whether this means supporting the user with writing and reading or exam preparation, it opens new doors to learning that were otherwise closed.

> *"You can shape learning materials to fit your own needs—like how you prefer to learn. That's especially great when the main way a course is structured or assessed doesn't match your learning style."* – Participant 11

> *"I already responded well to rewards as a kid, but streaks and levelling up were new concepts I discovered through AI tools."* – Participant 6

Participants especially highlight the ability of AI to adapt itself to their personal needs but even more so, it allows users to discover more about themselves and their hidden learning preferences which is a powerful discovery.

4.4.2 Inclusivity Improvements

Next to gaining access to ways of learning and resources, many participants have found themselves being more included in educational or professional environments due to AI usage. Most prominently, participants highlighted increased participation in educational activities at school or university, an increased sense of social belonging, as well as equal opportunities in comparison to others without learning struggles.

> *"With ChatGPT, I still had results I could share with the group. So, in that sense, I felt like I could contribute something meaningful to the group."* - Participant 10

"*Back in school, we had students who got extra support or were in different level groups. AI could help support those differences — even outside of school. If adapted to learning styles, it could offer even more options*" – Participant 3

For some, using AI-powered assistive tools resulted in the feeling of being part of the group without falling behind. The ability to learn with these tools clearly created a sense of inclusion among peers, reducing reliance on others and enhancing academic independence.

"When I talk to my friends about studying and say, "Hey, I have this great summary from ChatGPT," they ask me to share it. It creates a shared experience. I used to feel excluded when I didn't use AI." – Participant 4

Participant experiences show how AI assistive tools enhance chances for those with learning difficulties, creating an inclusive environment for everyone – not by replacing but by adding to human support.

4.4.3 Critical Access Gaps

Although most participants have reported a sense of increased inclusivity and accessibility in educational environments and for learning, few have shared that they have not experienced such situations due to AI tools. This experience was heavily dependent on the participants usage patterns and context, meaning that these were users with less frequent use or an overall critical view towards the tools in use.

"I think I'm less involved. If I read through an assignment carefully and plan how to approach it myself, I feel more engaged." - Participant 5

This statement shows how the participant feels less included due to a lack of engagement with academic assignments, which is the opposite from what most participants experienced. Next to this finding, the analysis showed clear barriers surrounding accessibility, showing technological and financial exclusion. Often, participants shared their experiences with pricing for regular or premium models and the cost of compatible devices, raising clear concerns about affordability and fairness. The affordability barrier was especially highlighted by university students, who were often not supported financially, for instance by institutions.

> *"ChatGPT has a €200 version that's more advanced than the €24 version I use—that's a big gap. It feels unfair that your answers could be better just because you pay more."* – Participant 6

> *"I don't think it's that inclusive because not everyone has access to a smartphone or a computer."* – Participant 8

These experiences highlight AI's clear impact and potential for inclusive and accessible learning; however, the AI tools themselves are marked by accessibility gaps and are not accessible to all. This may cause unintentional divides and hinder the potential of AI-powered assistive tools. Thus, it becomes clear that if the tools would become more accessible, AI would reach its full potential in supporting both accessibility and inclusivity.

In sum, participants showed that AI-powered assistive tools have the potential to increase accessibility of learning strategies and resources, as well as support inclusion in educational environments. Although many experienced AI tools in this way, some participants have shared lacking impact and clear barriers including affordability and access

to technology. To fully see what AI can do for learners with difficulties, these barriers must be broken down by financial solutions, ensuring equal access.

5. Discussion

This study explored the ways in which AI-powered assistive tools can impact accessible and inclusive learning for those with learning difficulties through qualitative research, including real user perspectives. As reflected by the findings, AI-powered assistive tools show potential due to their adaptive nature, their ease of use, and ability to enhance the need for competence among users. However, true impact is heavily dependent on the context in which the tools are used, how user motivation is affected, usability challenges, user frustrations, and gaps in equal access. To interpret these key findings, the discussion will revisit the research question of this study:

RQ: To what extent do AI-powered assistive tools make learning more accessible and inclusive for individuals with learning difficulties?

This includes addressing the sub-questions and linking them to prior scientific research. These questions focus on individual usage patterns, nuances in user motivation, and perceived usability and user experience which shapes user engagement. This chapter interprets the findings with a keen eye on existing literature and practical implementations.

5.1 Interpreting the Findings

The findings show how individuals with learning difficulties integrate AI-powered assistive tools into various areas of their lives to improve academic skills. These insights directly link to the first sub question which explores how individuals with learning difficulties use AI-powered assistive tools to enhance their academic performance. Areas do not only include academic use, but also professional and everyday contexts, in which learning plays a role. Participants highlighted their use for academic assignment support and exam preparation, professional writing support, and everyday language learning. As an example, most students used generative AI such as ChatGPT in high-pressure situations to summarize complex content or create revision questions for exams. In addition, many individuals in the

professional world appreciate ChatGPT and Grammarly for email writing support. These findings align with the theoretical understanding of AI as being widely applicable for diverse learning difficulties and areas of use, adapting itself to individual needs.

Existing literature mainly focuses on the use of AI-powered assistive tools in an academic context, on occasion highlighting personal use in the context of language learning (Panjwani-Charania & Zhai, 2023; Wang, 2024). As an addition to prior research, this study widens formal learning settings and includes both personal and professional challenges to the term ‘learning contexts’ of AI assistive tools, which could be embedded in the diverse sample. Furthermore, frequency and preferred tools were uncovered, highlighting participant preference. Most participants made use of AI tools regularly for challenging tasks, although there was no universal observation of everyday use. Participants, especially, make use of tools such as ChatGPT, however they have developed personal AI ecosystems, according to their needs. These findings underline how different tools match unique learning difficulties and are widely applicable to user needs as stated in literature (Papalexandratou & Stathopoulou, 2024). Thus, these findings do not only confirm prior research but extend it, showcasing how tool use and context depends on personal need. These findings showcase the importance of flexible and customizable AI for different contexts and needs.

Relating to user motivation, this study’s findings show nuanced insights into why participants desire to engage with AI-powered assistive tools, especially regarding self-determination theory. These findings connect to the second sub question, which asked about what motivates individuals with learning difficulties to use AI-powered assistive tools. Based on the three pillars of STD, competence emerged as the strongest need, supported by AI. Participants highlighted how assistive tools enhanced their skills, leading to confidence boosters and enhanced understanding. This finding clearly aligns with observations in earlier

studies, suggesting that AI-powered assistive tools empower individuals with learning difficulties (Alasgarova, & Rzayev, 2024).

In contrast to competence, the need for relatedness is not supported in the findings, showing that AI tools do not foster a sense of connection the same way as humans do. Reasons for this could be user knowledge about AI's robotic nature or even age differences and attitude towards AI. While AI supports a sense of competence, it is not ideal to mediate social connection during learning, as previously mentioned in literature (Du & Alm, 2024). This shows that for tools to be effective, they should be carefully balanced with human support to meet psychological needs.

The insights for autonomy are more complex, while still aligning with earlier studies. Some participants mentioned increased control and enhanced autonomy, while others show that over-reliance diminished independent and critical thinking. These mixed experiences represent what was found in earlier research, showing that autonomy is indeed inconsistent (Alasgarova, & Rzayev, 2024;Du & Alm, 2024). To some extent, these contradictions of autonomy might stem from experience with using AI supportive tools, how the tools are used, and AI literacy. As an addition to the motivation landscape, emotional drivers were reported by participants as their reason behind sustained use or disengagement. The main drivers mentioned are stress relief in high pressure situations and frustrations due to usability challenges, showing how perceived usability and UX are directly linked to technology adoption and engagement. Emotional motivation besides psychological needs was not yet an identified theme in earlier research, meaning that this study extended the motivational framework.

The findings show insights into perceived user experience and usability, with crucial factors emerging from the data that further impact user engagement with AI-powered assistive tools. These insights provide answers to the third sub question, which asked about

how users perceive the usability and overall user experience of AI-powered assistive tools. In this context, participants frequently highlighted their appreciation of AI functionalities such as personalization, simplified language output, conversational AI, and guided problem-solving, which allow AI interaction to be tailored to their needs.

Furthermore, ease of use was highlighted in form of simplicity and convenience, resulting in satisfaction with the tools. This seemingly aligns with the meaning of user-centered design principles described in literature, where developers are cautious to create tools that meet user needs and preferences to enhance satisfaction (Eziamaka et al., 2024). These findings match literature that emphasizes benefits of adaptive AI for personalized output, supporting learning difficulties and enhancing user experience (Usmani et al., 2023). However, the findings show a mix of satisfaction and frustration due to crucial usability barriers.

Participants show frequently encountered issues such as errors related to AI output, unexplained error messages, and the learning curve of teaching AI how to correctly interpret user needs. These barriers directly contradict the presence of human-centered design, resulting in a lack of effortless interaction with the tool and a hindered experience (Mayes & Fowler, 1999). In addition, participants highlighted the clear lack of AI transparency which resulted in a lack of trust in the tool. This finding connects strongly to what has been discussed in earlier research, calling for the need of transparent AI to support trust in learning contexts (Kumar & Bargavi, 2024). These barriers and frustrating experiences with AI-powered assistive tools need to be addressed to ensure continued engagement with AI-powered assistive tools and a positive user experience for learners.

By providing answers to the sub questions, the study builds towards addressing the overarching research question. Learner perspectives have shown how AI-powered assistive tools both can and cannot contribute to accessibility and inclusivity in education for those

with learning difficulties. Participants largely experienced significant improvements, especially highlighting learning support for deeper understanding and enhanced concentration. Furthermore, AI tools fostered a stronger sense of inclusivity through being able to participate more meaningfully, equal opportunities, and a sense of social belonging. Participants highlight strong support for enhanced accessibility of new learning strategies which are flexible and instantly match their personal learning styles, as well as access to new materials such as flashcards and articles. These findings closely relate to the theoretical debate on AI's potential to improve access to learning and create equal opportunities for individuals with difficulties (Bhakiyasri, 2024; Habib et al., 2022). Through personalized learning support offered by AI, which can be adapted to different learning needs, users directly benefit from more accessible and inclusive learning.

On the other hand however, these findings contradict with critical access gaps, and instances where participants did not highlight support. The main barriers were the financial cost associated with AI subscriptions, the fairness of having access to different models, and the barrier of needing up-to-date technology to have access to AI. Participants describe that while AI-powered assistive tools show potential to impact accessible and inclusive learning, the effect is undermined by financial and digital divides. These findings question widespread accessibility, a concept that thus far has not been explored in previous research. There is a clear need to address this issue and to consider underlying socio-economic factors when analyzing AI's true potential to make learning more inclusive and accessible.

5.2 Practical and Theoretical Implications

The findings described above offer insights for practical implications and further theoretical refinement around AI-powered assistive tools for accessible and inclusive learning. Practically, there are multiple ways in which the findings of this study can be implemented. First, the design of AI-powered assistive tools should place personalization and

adaptability as well as transparency for trust at its core. Thus, developers should prioritize research into diverse learning difficulties to allow for adaptive use. To enhance user experience and trust, transparency needs closer attention, making sure that AI discloses information about how data is used and how output is generated accordingly.

Furthermore, frustrating experiences should be minimized during development, leading to more accurate responses especially for math and logic related tasks. To more effectively support the need for autonomy, AI literacy and improved regulations for AI output could reduce over-reliance and superficial learning. In this sense, clearer boundaries for AI generated answers and usage guidelines can improve critical thinking when using AI for learning, encouraging individuals to truly engage with the tool without solely relying on its answers. Besides developers, educational institutions can improve AI implementation into learning environments to increase AI tool use as a supportive system when human support is not available. To break down accessibility barriers, institutions and policymakers should consider equalizing access to more precise premium versions by subsidizing through institutional licenses.

Theoretically, this study builds upon prior research by adding divers participant experiences to largely theoretical findings. In terms of user motivation, the findings add emotional drivers of tool use and their impact on sustained usage patterns. While findings in terms of self-determination theory – autonomy, competence, and relatedness – mostly match what can be found in theory, it is recommended for future research to build on autonomy nuances and AI's inability to foster relatedness. Most findings aligned with theoretical views on accessibility and inclusivity improvements; however, the access barriers are a crucial new discovery that need more in-depth research to be solved in practice. Finally, this qualitative study marks the start of research that centers user experiences with AI tools, underlining the need for more similar research in this field.

5.3 Research Limitations and Future Research

The applied methodology includes the following limitations that must be addressed. The sample size was recruited according to standards of qualitative research and inclusion criteria aligned with the objectives of this study. Nonetheless, the sampling procedure caused the sample to represent a relatively small portion of the population. Thus, most participants were recruited in a non-random manner, limiting the generalizability of the findings to a larger population. In this context, the research is careful to not make broad assumptions regarding all users of AI-powered assistive tools and advises future studies to consider a more random approach that aligns with the inclusion criteria.

Lastly, since this research is international, the interviews were translated into Dutch and German next to the English format. For the report, the transcripts were translated back into English, possibly causing meaning to get lost in translation. For future research into the field of AI-powered assistive tools for inclusive and accessible learning, it is essential to acknowledge the limitations of this methodology besides the crucial benefits of additional qualitative studies.

Thus, future research could benefit from minor changes to the methodology such as recruiting a broader sample with participants that are less connected to the researcher's close network, leading to enhanced generalizability. As an interesting finding from both prior research and this study, the need for autonomy emerged as mixed, making this a valuable concept to explore in future studies. For this, a valuable direction could be the role of AI literacy and training programs in shaping user autonomy and control over the learning process, thus influencing user motivation and experiences. Lastly, as mentioned earlier, a new topic that arose from this study is the impact of financial and technological accessibility of AI-powered assistive tools. Exploring this impact on equal access to learning tools appears to

be a crucial topic that needs to be explored further, including the possibility of institutional support to bridge these gaps.

5.4 Conclusion

To conclude this report, the main aim of this study was to find the extent to which AI-powered assistive tools impact inclusive and accessible learning for those struggling with learning difficulties. To achieve this, the focus lied on in-depth qualitative research with a user-focused approach to generate real-life experiences from individuals that interacted with such AI tools in different contexts of learning.

One of the key findings is that participants rely on diverse tools such as ChatGPT, Natural Reader, Grammarly, QuillBot, and others to support with different academic assignments, deadlines, and exam preparation – pointing towards enhanced use in stressful situations. In the findings, these tools showed their ability to positively impact competence, adapt to user needs, as well as actively relieve stress. However, it is important to spotlight the mixed signs for autonomy, showing how AI-powered assistive tools can create both control over learning but also overreliance on AI support and output. Users expressed their satisfaction with AI's ability to support brainstorming, explain complex concepts, and generate ideas; however, some showed concern about losing control and critical thinking.

As another crucial finding, this study underlines critical access gaps to learning technologies, creating mainly financial barriers. While this study analyzed AI's impact on accessible and inclusive education, it also uncovered that despite AI's potential, the tools themselves are not quite as accessible as they might seem. The findings show how AI-powered assistive tools foster inclusive and accessible learning – although, this effect is only possible through factors such as tool accessibility, minimizing frustrations, optimizing user experience, as well as the combination with human support.

As AI continuously develops and finds its way into our everyday lives, it is essential that we continuously keep user needs in mind to maximize its potential for support. It is of great importance to ensure that technology further assists with bridging gaps in equality, rather than widening them. Keeping this in mind, with further development and research, AI will empower more and more learners to achieve their academic goals and full potential.

References

Alasgarova, R. & Rzayev, J. (2024). The Role of Artificial Intelligence in Shaping High School Students' Motivation. *International Journal of Technology in Education and Science*, *8*(2), 311–324. https://doi.org/10.46328/ijtes.553

Arokiyaswamy, M. M., Rathod, P. & Aishwaryalaxmi, N. S. (2024). A Comprehensive Review of Self-Determination Theory: Exploring Challenges, and Impacts. *Power System Technology*, *48*(4), 6492–6499. https://doi.org/10.52783/pst.1456

Bhakiyasri, M. (2024). AI Enable Personalized Assistive Tools to Enhance Education of Disabled Persons and Its Legal Fallacies. *International Journal for Multidisciplinary Research*, *6*(6). https://doi.org/10.36948/ijfmr.2024.v06i06.31573

Barua, P. D., Vicnesh, J., Gururajan, R., Oh, S. L., Palmer, E., Azizan, M. M., Kadri, N. A. & Acharya, U. R. (2022). Artificial Intelligence Enabled Personalized Assistive Tools to Enhance Education of Children with Neurodevelopmental Disorders—A Review. *International Journal of Environmental Research and Public Health*, *19*(3), 1192. https://doi.org/10.3390/ijerph19031192

Brotosaputro, G., Supriyadi, A. & Jones, M. (2024). AI-Powered Assistive Technologies for Improved Accessibility. *International Transactions on Artificial Intelligence, 3*(1), 76–84. https://doi.org/10.33050/italic.v3i1.645

Chopra, A., Patel, H., Rajput, D. S. & Bansal, N. (2024). Empowering Inclusive Education: Leveraging AI-ML and Innovative Tech Stacks to Support Students with Learning Disabilities in Higher Education. In *Applied Assistive Technologies and Informatics for Students with Disabilities* (p. 255–275). https://doi.org/10.1007/978-981-97-0914-4_15

Dave, A., Saxena, A. & Jha, A. (2023). Understanding User comfort and Expectations in AI-based Systems. *Research Square*. https://doi.org/10.21203/rs.3.rs-3135320/v1

Du, J. & Alm, A. (2024). The Impact of ChatGPT on English for Academic Purposes (EAP) Students' Language Learning Experience: A Self-Determination Theory Perspective. *Education Sciences*, *14*(7), 726. https://doi.org/10.3390/educsci14070726

Eziamaka, N. N. V., Odonkor, N. T. N. & Akinsulire, N. A. A. (2024). AI-Driven Accessibility: Transformative Software Solutions for Empowering Individuals with Disabilities. *International Journal of Applied Research in Social Sciences*, *6*(8), 1612–1641. https://doi.org/10.51594/ijarss.v6i8.1373

Fengjuan, W. & Jamaludin, A. (2023). The Science of Mathematics Learning: An Integrative Review of Neuroimaging Data in Developmental Dyscalculia. In *Applying the Science of Learning to Education* (p. 55–78). https://doi.org/10.1007/978-981-99-5378-3_3

Fitria, T. N. (2021). Grammarly as AI-powered English Writing Assistant: Students' Alternative for Writing English. *Metathesis Journal of English Language Literature and Teaching*, *5*(1), 65. https://doi.org/10.31002/metathesis.v5i1.3519

Gorai, S. (2024). Attention-Deficit/Hyperactivity Disorder in Children and Adolescents. *African Journal of Biological Sciences*, *6*(10), 613–616. https://doi.org/10.48047/afjbs.6.10.2024.613-616

Habib, H., Jelani, S. A. K. & Najla, S. (2022, 25. February). *Revolutionizing Inclusion: AI in Adaptive Learning for Students with Disabilities*., *1*(1) https://multidisciplinaryscience.com/index.php/msj/article/view/1

Hassenzahl, M. & Tractinsky, N. (2006). User experience - A Research Agenda. *Behaviour and Information Technology*, *25*(2), 91–97. https://doi.org/10.1080/01449290500330331

Jamil, N., Alawa, O. S., Manar, S. M., Alaidarous, S. A., Adam, A. S., Eldemerdash, S. A. & Belkacem, A. N. (2023). On Neurodevelopmental Disorder based on Brain Computer Interface for Enhancing the Learning Process. *2021 IEEE Frontiers in Education Conference (FIE)*, 1–9. https://doi.org/10.1109/fie58773.2023.10343434

Kavanagh, B., Tohoku University, Japan. (2022). Assessing AI-based Summarizing and Paraphrasing Tools for a CLIL Intercultural Communication Academic Writing Class. In *Intercultural Communication Studies* (p. 93–94) https://www-s3-live.kent.edu/s3fs-root/s3fs-public/file/7-KAVANAGH.pdf?VersionId=4ss7qZkhkp3E5EBIya7Mir4LbZNZfoJY

Krüger, R. J., Krüger, J. J., Hugo, R. & Campbell, N. G. (2001). Relationship Patterns Between Central Auditory Processing Disorders and Language Disorders, Learning Disabilities, and Sensory Integration Dysfunction. *Communication Disorders Quarterly*, *22*(2), 87–98. https://doi.org/10.1177/152574010102200205

Kumar, S. & Bargavi, S. (2024). Trust's Significance in Human-AI Communication and Decision-Making. *Intentional Journal of Scientific Research in Engineering and Management*, *08*(02), 1–10. https://doi.org/10.55041/ijsrem28468

Lee, C. P. (2024). Design, Development, and Deployment of Context-Adaptive AI Systems for Enhanced End-User Adoption. *arXiv (Cornell University)*. https://doi.org/10.48550/arxiv.2401.13643

Mayes, J. & Fowler, C. (1999). Learning Technology and Usability: a Framework for Understanding Courseware. *Interacting With Computers*, *11*(5), 485–497. https://doi.org/10.1016/s0953-5438(98)00065-4

Moraiti, I. & Drigas, A. (2023). AI Tools Like ChatGPT for People with Neurodevelopmental Disorders. *International Journal of Online and Biomedical Engineering (iJOE)*, *19*(16), 145–155. https://doi.org/10.3991/ijoe.v19i16.43399

AI voices - NaturalReader Home. (n. d.). https://www.naturalreaders.com/

Panjwani-Charania, S. & Zhai, X. (2023, 30. October). *AI for Students with Learning Disabilities: A Systematic Review*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4617715

Papalexandratou, N. P. & Stathopoulou, N. A. (2024). The Use of Artificial Intelligence in the Education of Students with Learning Disabilities. *Global Journal of Engineering and Technology Advances*, *21*(3), 033–049. https://doi.org/10.30574/gjeta.2024.21.3.0223

Real-time Continuous Transcription with Live Transcribe. (n. d.). https://research.google/blog/real-time-continuous-transcription-with-live-transcribe/

Sampson, H. (2004). Navigating the Waves: The Usefulness of a Pilot in Qualitative Research. *Qualitative Research*, *4*(3), 383–402. https://doi.org/10.1177/1468794104047236

Stephanidis, C. (2023). Paradigm Shifts Towards an Inclusive Society: From the Desktop to Human-Centered Artificial Intelligence. *Association for Computing Machinery*, 1–4. https://doi.org/10.1145/3609987.3610109

Usmani, U. A., Happonen, A. & Watada, J. (2023). Human-Centered Artificial Intelligence: Designing for User Empowerment and Ethical Considerations. *HORA*, 1–7. https://doi.org/10.1109/hora58378.2023.10156761

Vidyadharan, V. & Tharayil, H. M. (2019). Learning Disorder or Learning Disability: Time to Rethink. *Indian Journal of Psychological Medicine*, *41*(3), 276–278. https://doi.org/10.4103/ijpsym.ijpsym_371_18

Wang, Q. W. (2024, 30. October). AI-driven Autonomous Interactive English Learning Language Tutoring system. *Sage Journals*. https://journals.sagepub.com/doi/full/10.1177/14727978241296719

Wood, S. G., Moxley, J. H., Tighe, E. L. & Wagner, R. K. (2017). Does Use of Text-to-Speech and Related Read-Aloud Tools Improve Reading Comprehension for Students with Reading Disabilities? A Meta-Analysis. *Journal of Learning Disabilities*, *51*(1), 73–84. https://doi.org/10.1177/0022219416688170

Wodzak, S. (2024, 31. December). *How Duolingo is Using Artificial Intelligence for Social Good*. Duolingo Blog. https://blog.duolingo.com/ai-improves-education/

Appendix A

Interview Guide

1. Introduction:

Thank you for participating in this interview. I am a student from the university of Twente, conducting this interview as a part of my bachelor thesis research. With this interview, I aim to explore experiences and perceptions of individuals that face diverse forms of learning difficulties, and who have encountered AI-powered assistive tools for learning. The focus of my research lies on how AI-powered assistive tools impact accessible and inclusive education. The knowledge gained from this interview will contribute to painting a bigger picture of user experiences and challenges when it comes to AI-powered assistive tools, uncovering their practical applications and limitations.

The data collected from this interview will be treated confidentially and the anonymity of the participant will be valued, as stated in the informed consent. After reading the informed consent carefully, do you agree to continue your participation, and do you consent to a recording of the interview? If during the interview, you have a question or wish to end your participation, please do not hesitate to interrupt. You can end the interview at any time.

2. Icebreakers

- Can you introduce yourself and briefly describe your current occupation?

Before we start with further questions, to ensure our mutual understanding of the term 'AI-powered assistive tools' for learning, can you briefly explain how you would define these tools and give an example?

[A technology based on artificial intelligence which is developed to support those with learning difficulties, creating an adaptive and personalized learning environment by relying on machine learning systems. Examples can be Duolingo as an intelligent tutor for languages or chatbots with the ability to summarize texts]

- Can you describe the experience that you have had so far with AI-powered assistive tools?
- How often are you currently integrating AI-powered assistive tools into your daily life?

3. Topic 1: Usage of AI-powered assistive tools

- Can you explain in detail how you currently make use of AI-powered assistive tools for learning in everyday life, your career, or academic journey?
  - If possible, include concrete examples of the tools that you use
- Please explain about the specific scenarios or tasks in which these tools support you or do not support you
  - Can you tell me why that is?

- Could you walk me through a typical day or moment where you use one of these tools?

4. Topic 2: Adoption & motivation to use AI-powered assistive tools

- Can you explain in detail why you started to make use of these AI-powered assistive tools?
- Did you experience any AI-powered assistive tools that you are less motivated to use or stopped using completely?
  - Why do you think that you stopped using them regularly?
- Why do you think that you continued to make use of other AI-powered assistive tools?
- Do these tools help you to feel more in control of your own learning?
  - Please elaborate on your answer
- Do you feel like you can achieve a human-like connection with AI-powered assistive tools?
  - Please explain further why that is
- In what way do AI-powered assistive tools make you feel more capable or skilled?
  - Can you give specific examples?
- Can you describe your feelings before and after you used a tool? Do they influence your self-esteem or levels of stress?

5. Topic 3: Perceived usability

- What features do you find most helpful when you are learning?
  - Why are they useful for you?
- Do you experience any challenges with the AI-powered assistive tools that you use most?
  - Can you tell me about a time when using one of these tools was difficult or annoying?
  - Please explain why you think this happened
- If you could change one thing about the tools you use, what would it be and why?

6. Topic 4: Impact on accessible and inclusive learning

- Do AI-powered assistive tools make you feel more included in learning or work situations?
  - please give concrete examples of when these tools helped you take part in something – like a conversation or an educational activity – that you otherwise would have missed out on.
- Can you explain how AI-powered assistive tools influenced your access to new ways of learning?
- In what ways have these tools influenced your access to new learning materials?
- In general, please explain your opinion about how AI-powered assistive tools can impact inclusive and accessible learning

7. Closing

- Do you have any further ideas or experiences that you would like to share?

- Do you have any questions relating to this research?

Thank you for participating in this study. If you have any further questions, please do not hesitate to contact me.

Appendix B

Information Sheet

From Struggles to Strengths: Exploring How AI-Powered Assistive Tools Shape Inclusive and Accessible Learning

Researcher: Anna Mathilde van Adrichem, Bachelor Student, University of Twente
Last edited [14.04.2025]

You are invited to take part in this user-focused study which aims to explore how individuals with learning difficulties make use of AI-powered assistive tools to reach their academic goals. The objectives of this study are focused on discovering how these tools influence accessible and inclusive learning through personal experiences that users of AI-powered assistive tools have made.

This study consists of an interview that will last approximately 45 to 60 minutes, in which you will be asked to share your personal thoughts and experiences with AI-powered assistive tools in four different categories: usage of AI-powered assistive tools, motivation to use AI-powered assistive tools, perceived usability, and impact on accessible and inclusive learning.

There are no direct benefits connected to your participation, however, your personal experiences and insights will contribute to the overall development of AI-powered assistive tools and how they can be improved to support those with learning difficulties, as well as to AI policymaking for various educational settings. There are no known risks associated with your participation in this study, and you will not be required to share any medical or diagnostic details. However, if you notice any feelings of discomfort, do not hesitate to interrupt the interview at any moment. You can skip any questions that you do not wish to answer without stating a reason. To ensure that this research project aligns with all ethical guidelines, it has been reviewed and approved by the Ethics Committee of the Faculty of Behavioral, Management, and Social Sciences (BMS), University of Twente (Humanities & Social Sciences Domain).

Your participation in this study is entirely voluntary. After signing the informed consent, you can still choose to withdraw from your participation at any time, without further consequences. If you decide to end your participation, all collected data will be removed from the results.

The interview will focus on collecting only essential demographic information and your personal experiences with AI-powered assistive tools for learning. No information will be gathered that directly identifies you as a participant. All data will be anonymized, and no personal data will be published in the final report. If you have any concerns about specific data that you would like to remove from the final report, feel free to reach out to me.

With your consent, your responses will be audio recorded and treated confidentially. All audio recordings will be stored password-protected on the researcher’s personal device. The transcripts and raw data can only be accessed by the researcher and academic supervisor for further analysis. After the research project is completed, audio files will be destroyed and

only transcripts will be stored. The final data and results will be presented in my bachelor thesis and bachelor defense presentation. The transcripts will be archived in the database of the University of Twente under controlled access for future research.

Informed Consent Form

YOU WILL BE GIVEN A COPY OF THIS INFORMED CONSENT FORM

Please tick the appropriate boxes	**Yes**	**No**
Taking part in the study		
I have read and understood the study information dated 14.04.2025, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	□	□
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions, and I can withdraw from the study at any time, without having to give a reason.	□	□
I understand that taking part in the study involves sharing my personal experiences with AI-powered assistive tools in an audio-recorded interview. I was informed that the audio recordings will be destroyed after transcription.	□	□
Use of the information in the study		
I understand that information I provide will be used for the final bachelor thesis report and during the bachelor defense presentation.	□	□
I understand that personal information collected about me that can identify me, such as e.g. my name, will not be shared beyond the study team.	□	□
I agree that my information can be quoted in research outputs.	□	□
I agree to be audio recorded.	□	□
Future use and reuse of the information by others		
I give permission for the anonymized transcribed data that I provide to be archived in the data repository of the University of Twente so it can be used for future research and learning.	□	□

Signatures

_____	_____	_____
Name of participant	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Researcher name.	Signature	Date

Contact details for further information:

Anna Mathilde van Adrichem
Email: a.m.vanadrichem@student.utwente.nl

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee/domain Humanities & Social Sciences of the Faculty of Behavioral, Management and Social Sciences at the University of Twente by ethicscommittee-hss@utwente.nl

Appendix C

Final Codebook

1. Usage of AI-powered assistive tools

- *Tool types*
- *Context of use*
    - Academic Context
        - Academic – Assignment Support
        - Academic – Exam Preparation
        - Academic – Feedback & Corrections
        - Academic – Language Support
        - Academic – Source Reading & Comprehension
        - Academic – Study Planning
        - Academic – Summarizing Material
        - Academic – Text-To-Speech
        - Academic – Writing Support
    - Professional Context
        - Professional – Ideas & Creativity
        - Professional – Job Search & Skill Checks
        - Professional – Writing Support
    - Everyday Context
        - Every day – Athletics & Learning
        - Every day – Hobbies & Learning
        - Every day – Language Learning
        - Every day – Learning New Information
- *Frequency of use*

2. User Motivation

- *Initial motivation*
    - Curiosity
    - Efficiency
    - Need for Support
    - Peer Influence
- *Sustained use*
    - Efficiency
    - Functional Dependence
    - Gamification
    - Personalization Over Time
- *Decreased use*
    - Lack of Support
    - Unfit with Personal Needs
- *Autonomy*
    - Autonomy Not Supported
    - Autonomy Partially Supported
    - Autonomy Supported
- *Competence*

    - Competence Not Supported
    - Competence Supported
- *Relatedness*
    - Relatedness Not Supported
    - Relatedness Partially Supported
    - Relatedness Supported
- *Emotional Motivation*
    - Positive Emotion Enhancement
    - Stress Reduction
    - Increased Guilt

3. Perceived usability

- *Ease of Use*
    - Convenience
    - Lack of Errors & Frustrations
    - Simplicity
- *Functionality*
    - Adaptivity & Personalization
    - Answer Variability
    - Conversational AI
    - Gamification
    - Guided Problem Solving
    - Idea Generation
    - Limited – Graphic Design
    - Multimodal Input & Image Upload
    - Plain Language Output
    - Productivity Support
    - Tool Comparison
- *Barriers/technical issues*
    - AI Outage
    - Error Messages
    - Input Errors
    - Lack of Capacity
    - Output Errors
- *Suggestions for improvement*
    - Develop Boundaries
    - Expand Formats
    - Improve Accessibility
    - Improve Accuracy
    - Improve Privacy
    - Improve Task-Oriented Focus
    - Reduce Complexity

4. User Experience

- *Satisfaction*
    - Emotional Boost

    - Fulfills Its Purpose
    - Helpful Functions
    - Smooth Process
- *Frustrations*
    - Answer Accuracy & AI Hallucination
    - Conflicting Information
    - Error Corrections & Inefficiency
    - Ethical Concerns
    - Inconsistency
    - Initial Learning Curve
    - Lack of Naturalness & Human Touch
    - Math/Logic Frustrations
    - Misalignment with User Needs
    - Perceived Lack of Progress
- *Trust in AI*
    - Critical Trust
    - Established Trust
- *Transparency of AI*
- *Comfort with AI vs Human Support*
    - Comfort with AI Support
    - Preference For Human Support

5. Impact on accessible and inclusive learning

- *Accessibility improvements*
    - Access to Learning Materials
    - Access to Learning Strategies
- *Accessibility Not Supported*
- *Inclusivity improvements*
    - Equal Opportunities
    - Increased Participation
    - Social Belonging
    - Widespread Access
- *Inclusivity Not Supported*
- *Learning Support*
    - Cognitive Overload Reduction
    - Deeper Understanding
    - Enhanced Concentration
    - Language Support
    - Organization & Structure Support
    - Personalized Learning Support
    - Writing & Reading Support
- *Accessibility Barriers*
    - Affordability
    - Technology Access

Codebook Clarifications

Usage Patterns

Code	Definition	Example Quote
Context of Use – Academic	AI supports learning in an academic context, e.g. at school or university.	"Currently studying Communication Science at the University of Twente. I'm in my second year." – Participant 3
Context of Use – Professional	AI supports with learning in a professional context, e.g. at work when writing texts, emails, or applications.	"I enter my emails into ChatGPT, ask it to rewrite or check spelling, and usually get a good result." – Participant 7
Context of Use – Everyday	AI supports learning in a day-to-day context, e.g. learning languages in free time or improving writing skills.	"I even use gamification in daily life—like competing with my mom on Duolingo, just for fun." – Participant 6
Frequency of Use	How often is the AI-powered assistive tool used?	"Almost daily, especially because of my thesis." – Participant 6
Tool Types	Which type of AI-powered assistive tool is being used for learning?	"Examples would be ChatGPT, for instance. Our university has its own AI-supported learning tool that's based on ChatGPT" – Participant 1

User Motivation

Code	**Definition**	**Example Quote**
Initial Motivation	The initial motivation for the use of an AI-powered assistive tool.	"When I started university and learning became more independent. […] So, you must figure things out for yourself. And understanding the scripts and documents provided isn't always easy." – Participant 1
Sustained Use	Reasons and motivation for continued use of AI-powered assistive tools.	"And you're encouraged by things like streaks, which motivate you to keep learning so that you

		don't lose your streak. And yes, that's the kind of motivation I have to keep going every day." – Participant 8
Decreased Use	Reasons for decreased use of AI-powered assistive tools or a lack in motivation, causing a drop-off.	"For example, I used Duolingo for language learning but switched to other resources like videos, which suited me better." – Participant 12
Emotional Motivation	Describes how using an AI-powered assistive tool affects emotional states, and therefore their motivation. This includes feelings of relief, guilt, motivation, or frustration.	"It can reduce stress in high-pressure situations — like right before deadlines — if it gives helpful answers." – Participant 1
Autonomy	*Self Determination Theory:* Autonomy relates to the feeling one has choice and is willingly endorsing one's behavior, and whether this is supported by AI.	"Back in high school, I struggled when I switched school systems. If I had something like ChatGPT back then, I could've used it to learn the basics on my own, even outside class." – Participant 6
Competence	*Self Determination Theory:* Competence refers to the mastery and being effective in one's activity, and whether this feeling is supported by AI.	"They help me finish tasks faster — that makes me feel competent." - Participant 4
Relatedness	*Self Determination Theory:* Relatedness refers to the need to feel connected and a sense of belonginess, and whether this is supported by AI.	"But I still know I'm talking to a system, not a person." – Participant 3

Usability

Code	**Definition**	**Example Quote**
Ease of Use	How easily users can make use of AI-powered assistive tools for learning.	"It's super user-friendly. You can do searches, upload files, create designs — all in one place." – Participant 3

Barriers & Technical Issues	Challenges and technical issues that hinder the use of AI-powered assistive tools, thus creating barriers within the support system.	"Sometimes you get error messages like "Oops, something went wrong." – Participant 2
Functionality	The perceived functionality of a tool and whether the tools functions work to meet the users' goals.	"For example, that you can insert photos, and it recognizes them." – Participant 10
Suggestions for Improvement	The users' personal suggestions for improvements, based on their individual learning style.	"Another thing I would like, which relates more to what already exists, is that the tool could be more precise." – Participant 9

User Experience

Code	**Definition**	**Example Quote**
Satisfaction	Interactions with AI-powered assistive tools that led to feelings of satisfaction.	"I only use the paraphrasing function — but I find it really useful." – Participant 5
Comfort with AI Vs. Human Support	The difference in comfort with AI-powered technologies for learning vs. interacting with humans.	"It's basically a support system when you don't have someone to ask, or when you want something explained in another way." – Participant 1
Frustrations	Interactions with AI-powered assistive tools that led to frustrations	"Sometimes ChatGPT still makes small errors—like inventing repeated phrases that aren't there" – Participant 6
Trust in AI	The ways in which users of AI-powered assistive tools can trust AI.	"But people still need to be critical — especially for kids using AI unsupervised." – Participant 3
Transparency of AI	The ways in which AI-powered assistive tools how transparency in their communication.	"But mainly, the privacy issue bugs me the most. Even if you switch off data sharing, you never know what's really being stored." – Participant 2

Accessibility and Inclusivity Improvements

Code	Definition	Example Quote
Learning Support	How AI tools support understanding, comprehension, or skill development, especially where traditional recourses fall short.	"I have trouble focusing and tend to fixate on small, irrelevant details. ChatGPT helps guide me back to what's important." – Participant 4
Accessibility Improvements	The ways in which AI-powered assistive tools can improve accessibility for learning.	"They let you tailor study and learning materials to your own needs. You can fully customize how you learn." – Participant 11
Inclusivity Improvements	The ways in which AI-powered assistive tools can improve inclusivity for learning.	"I started using them because I felt excluded, but now they help me keep up and participate more actively—especially in group work" – Participant 6
Accessibility Not Supported	In case there's no true signs of access to new ways of learning or new learning resources.	"Not really. I'm structured on my own and don't need help organizing tasks." – Participant 7
Inclusivity Not Supported	AI-powered assistive tools have not influenced a sense of inclusion for the participant, or they were not yet experienced.	"They boost my confidence, but inclusion depends more on the person than the tool." – Participant 12
Accessibility Barriers	Barriers to accessibility due to AI-powered assistive tools that can be related to cost or limited access to technology.	"For example, ChatGPT has a €200 version that's more advanced than the €24 version I use—that's a big gap. It feels unfair that your answers could be better just because you pay more." – Participant 6

Appendix D

AI Disclosure

This thesis report includes the use of AI tools that have supported the research and writing process. Especially Scribbr and Grammarly were used to support correct referencing according to the standards of APA7, and to ensure that the report is free of grammatical errors. Furthermore, since this is a complex study in terms of languages, DeepL was used as a supportive tool to save time with translating the transcripts back to English. All content reported in this thesis is original and it is ensured that AI was not used for any other purpose. With this statement, the report ensures to be in line with institutional guidelines towards AI use.