ADHD Accessibility for E-Learning in Higher Education

Jack McDermott

4th Year Project Report
Computer Science
School of Informatics
University of Edinburgh

2024

Abstract

Students with ADHD may struggle in the transition between secondary and higher education, this struggle can be amplified by e-learning as it puts distractions close within reach of the student. There is a current lack of support for students with ADHD undertaking e-learning, seen both through the low amount of research within the field and through personal anecdotes from students.

This paper set out to discover what specific elements of online learning those with ADHD struggled with. A literature review was conducted on the current state of e-learning for those with ADHD, this was followed up by some small semi-structured interviews with five current university students from different degree programs who are currently diagnosed with ADHD. The researcher designed a tech-based solution in the form of a reading assistant. This idea was turned into a low-fidelity prototype, which the same pupils and a staff member with ADHD evaluated.

The prototype was then transformed into a high-fidelity prototype via an iterative development process, with an initial evaluation conducted during the Informatics Product Day Event to aid the development and gauge a broader usefulness for the extension. Finally, the tool was evaluated by eight experts within the areas of Informatics, ADHD, Accessibility and User Experience/Design. The evaluation showed promising results and proved that the tool has a high potential to target multiple forms of accessibility challenges.

Research Ethics Approval

This project obtained approval from the Informatics Research Ethics Committee.
Ethics application number: 809800
Date when approval was obtained: 2024-01-15
The participants' information sheet and a consent form are included in the appendix.

Declaration

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

(*Jack McDermott*)

Acknowledgements

I would like to thank my supervisor Dr. Aurora Constantin who provided incredible support, guidance, feedback, and encouragement throughout this project.

I would like to thank the participants who aided me throughout this project with their time, honesty, feedback, encouragement, and genuine enthusiasm. Their input made this project possible.

I would also like to extend my thanks to all the experts who provided me with invaluable insights.

I would like to thank my Mum, Dad, and Erica, for their endless support, suggestions, encouragement, and time.

Finally, I would like to thank my flatmates and friends, for their moral support, listening, and cooking.

Table of Contents

Chapter 1

Introduction

1.1 ADHD

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder often diagnosed in childhood that can persist into adulthood and create significant challenges in higher education [1][2]. The disorder's core characteristics are inattention, hyperactivity, and impulsiveness. ADHD is underdiagnosed [3], particularly within specific demographics such as women and highly intelligent individuals [4]. This underdiagnosis, coupled with often inadequate support systems [5], creates significant challenges for those with ADHD.

The transition from secondary education to higher education can be challenging for those with ADHD, often resulting in declining academic performance and higher drop-out rates due to the increased freedom and responsibility [2]. E-learning, increasingly common in higher education, poses unique challenges for students with ADHD. The abundance of distractions within close reach inherent in use of technology can easily derail focus and concentration. Additionally, challenges arise due to university students choosing not to disclose their ADHD diagnosis. Anecdotal data shows students believe the support offered will be inadequate or, in the case of foreign diagnoses, require difficult reevaluations from the NHS - with an 18-month waiting list, or via private services for a high fee averaging £973 (Appendix A.1).

1.2 Project Goals and Research Questions

This project investigates the design and development of a technological solution to support university students with ADHD within e-learning environments. An immediate challenge identified stems from the inattention characteristic of ADHD, and its consequences for focus. Through direct collaboration with users, this project aims to pinpoint the unique challenges posed by inattention and lack of focus during university-level e-learning. This allows for the identification of a specific focus-related issue to target and address. The ultimate goal is to create a technological solution that directly meets user needs. The project adopts a user-centred design (UCD) approach [6], actively

involving stakeholders from the outset and continuously prioritising their vision throughout the design process. Stakeholders include current university students diagnosed with ADHD and experts in fields such as ADHD and Human-Computer Interaction (HCI). To achieve this, the following research questions are addressed:

RQ1: What are the main challenges faced by students with attention disorders at university, especially in e-learning?

RQ2: How can a tech-based solution be designed to help students with ADHD overcome their challenges?

RQ3: How effective is the tool in aiding users with ADHD in university?

1.3 Structure of the Dissertation

The research project is divided into seven chapters, and the remaining content is structured as follows:

Chapter 2: This chapter presents the literature review on ADHD and e-learning, with a particular focus on ADHD students in higher education. It then investigates the current tools and techniques available that provide assistance to those with ADHD. The chapter ends with the design guidelines followed throughout the project's development.

Chapter 3: This chapter focuses on the pre-design stage, including semi-structured interviews conducted with five university students diagnosed with ADHD. It then discusses the results gained from a combination of the background literature and the interviews, which lead to an initial set of design suggestions.

Chapter 4: This chapter contains a description of the low-fidelity prototype created based on the previous chapter's findings. It then presents an evaluation study with four of the same students with ADHD and one expert, on the prototype. The chapter closes discussing the revised design considerations.

Chapter 5: This chapter presents the high-fidelity prototype implemented as a Google Chrome Extension, developed based on the gathered suggestions. It describes the technical decisions, design choices and functionalities, alongside the justifications behind each.

Chapter 6: This chapter contains the evaluation of the high-fidelity prototype, which was conducted over two different studies: an initial evaluation conducted with 23 participants during the Informatics Project Day event, and summative evaluation conducted with the original five participants from the first study and eight experts in ADHD, HCI, accessibility and informatics.

Chapter 7: This chapter answers the research questions based on the results from the evaluation studies, discusses the limitations, and suggests directions for future work.

Chapter 2

Background Chapter

This chapter discusses the current state of ADHD in society, mainly focusing on the context of attention disorders in e-learning during higher education (HE). Furthermore, it explores the various tools available to assist ADHD students with e-learning in HE. In addition, this chapter presents Nielsen's Heuristics [7], Gestalt's Principles [8] and an adaptation of Lorna McKnight's ADHD guidelines [9]. This chapter aims to answer **RQ1** *"What are the main challenges faced by students with attention disorders at university, especially in e-learning?"*.

2.1 ADHD in Higher Education - Issues

2.1.1 ADHD Overview

Attention Deficit Hyperactivity Disorder (ADHD), previously known as Attention Deficit Disorder (ADD), is the current term for the disorder encompassing predominantly hyperactive-impulsive presentation, predominantly inattentive presentation, and a combination of both. These are the most common traits experienced by those with ADHD [10]:

- Inattention - This includes, struggling to pay attention for varying lengths of time, not retaining the information that was just presented, problems following directions/orders, and being disorganised.
- Hyperactivity - This can be, but is not limited to, being unable to sit still, constantly fidgeting and moving, talking excessively, and struggling to stay focused on tasks.
- Impulsivity - This can include interrupting others, acting without thinking, and being impatient.

A common misconception about ADHD is that it can simply be outgrown, due to it being often referred to as a "childhood disorder". Additionally, a lot of the traits shown by those with ADHD are commonly miscategorised as immature. According to the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), published by the American Psychiatric Association, these traits can include an inability

to focus on tasks, avoiding tasks that require continued mental effort, and being easily distracted by external stimuli [1]. In reality, the majority of children with ADHD will continue to exhibit significant symptoms into adulthood [11] [12]. The diverse manifestation of ADHD symptoms significantly influences this experience. For example, individuals with ADHD may experience internalised hyperactivity and compensate for inattention through excessive work against it. These coping mechanisms such as obsessive work became significantly more difficult to maintain during the challenges of online learning and working from home due to the COVID-19 pandemic [3].

Currently, an estimated 5% to 10% of school-age children have ADHD [13] [14]. However, less is known about the statistic of ADHD among higher education students. This knowledge gap is due to factors such as students not reporting their diagnoses and increased online learning heightening and therefore exposing ADHD symptoms. Additionally, a complex diagnostic process requires professionals to carefully distinguish ADHD from other disorders or learning difficulties that share similar traits [15]. As a result, many university students are likely to struggle with undiagnosed attention disorders and lack the necessary support.

Research demonstrated by *Sedgwick-Muller et al.* [16] calls for more effort and support for ADHD, particularly within universities. Their paper scrutinises the misconception that ADHD is a specific learning difficulty, instead changing that focus to ADHD being a disorder that will affect a lot more than a student's grades. It emphasises the urgent need to ensure all students at university who have ADHD should get quick access to essential support and assistance. This effort that should be made will aim to provide students with ADHD an equal opportunity to succeed, putting them on a level playing field as their neurotypical peers and colleagues.

2.1.2 E-Learning Currently

Recently, due to the pandemic, there has been a surge in the popularity of e-learning. While present for a longer period, universities have significantly increased their use of e-learning since the start of the pandemic in 2020 [17]. As a rapidly expanding field, e-learning lacks extensive research into its long-term effects

A major benefit of e-learning is the enhanced accessibility it provides. Examples include; subtitles on lecture videos, the flexibility of being able to view them at any time, and pausing and rewinding to fully understand what was said. Additionally, e-learning can be advantageous financially, for example, temporary PDFs replacing high textbook costs. Furthermore, electronic formats increase accessibility, enabling users to use tools such as screen readers [18].

While online education offers potential benefits in terms of flexibility and convenience, it presents unique challenges. A recent study by *B.M. Amerneh et al.* [18] revealed that many students struggle with the lack of interaction with peers and instructors. Furthermore, many institutions have simply adapted in-person lectures to online formats without significant modification. Research indicates that this approach is less effective than breaking long lectures into shorter videos with interactive elements [19]. A lack of engagement is worsened by the distractions inherent in home environments, further

impacting student focus and motivation [18].

2.1.3 ADHD in Higher Education

ADHD is managed more easily in secondary education as there is an imposed structure, constant monitoring, and help from professionals to keep pupils on track. However, when starting Higher Education, many students find it difficult to keep up with what is expected from them due to the responsibility of having to look after themselves, not just academically, but in all aspects of life. There are huge differences between secondary and higher education, such as having to decide your schedule, doing your chores like shopping, cooking, cleaning, laundry, and managing your finances, this causes a many individuals to struggle with the large amount of responsibility and freedom thrust upon them in such a short space of time. Those with ADHD are particularly vulnerable when entering higher education, given the blend of heightened responsibilities and the ready availability of dangerous outlets like drugs and alcohol. Combining this with a large step-up in academic challenges provides a multitude of opportunities for individuals with ADHD to make bad decisions [16]. As a result, students with ADHD are 85% more likely to drop out in their first year than neurotypical students [2].

Learning through e-learning can pose a number of challenges for those with ADHD [20], simple things such as reading from a digital source can cause retention to be more challenging [21]. Individuals may struggle with cognitive flexibility, hindering their ability to hold multiple concepts in mind simultaneously, which can be particularly challenging when faced with have multiple deadlines for different coursework, or simply navigating to new websites to try to understand something new or find a different resource while learning [22]. Problems with working memory also come due to the inattention trait, which means students with ADHD can read text but struggle to recall it when prompted, especially if they find the text is uninteresting [23].

Many of the challenges students encounter in e-learning and higher education generally are also common issues for individuals with ADHD. Consequently, students with ADHD may face even greater difficulties when working online and will often require extra support to maintain motivation, engagement, and focus.

2.1.4 Tools for ADHD

People with ADHD currently use a range of tools, some designed specifically for individuals with ADHD and others intended for broader audiences yet beneficial to the ADHD population. While this research centres on technological solutions, the researcher extends the scope to identify non-technical potential features and methodologies suitable for adaptation into an original solution. These tools have been split into rough categories to help create a more accurate view of what is currently available and what those tools may assist with. There will naturally be some grey area between tools and categories. This overlap will be caused by tools incidentally or purposefully tackling two things at once, for example, some tools that assist with focus may inadvertently motivate users to get to the focus state as they will have a short-term goal to start the app.

Reading Assistance: Some technological solutions include Text-To-Speech (TTS).

TTS has such a high value for accessibility that it is embedded into many different software and tools. It can help those with ADHD specifically, as it enables users to consume their written content when they begin to find their reading tedious. A potential drawback is that people might not want to or might not be able to listen. Spreeder [24], also offered as ”wordrunner” on Kindle, is a method of reading designed to teach users speed reading techniques. They flash each word on the screen (usually one at a time) so your eyes do not have to move; this lack of distraction with only making the user focus in one place can be helpful for those with ADHD who might be easily distracted by their eyes moving around a screen. Bionic reading is another technology-based technique which promotes speed reading. It consists of highlighting the first few letters of each word to help guide the reader's eyes [25]. Simply using a ruler/highlighter to identify where they are and reduce distractions when reading can significantly help with keeping one's attention whilst reading, or to direct their focus to what is important.

Gamified Approaches: Fabulous: Motivate Me! [26] is an app that leverages the idea that people with ADHD have large bursts of productivity, but this quickly fizzles out with time. The app creates tiny daily goals of good habits for the user, such as drinking x glasses of water per day, slowly building them up over time. Whilst not necessarily for ADHD, the popular language learning app Duolingo [27] is a highly successful example of gamified learning. However, there are drawbacks to a gamified approach: for example, users might not feel it would be the best current time to use the app as they will not receive as large an in-game benefit, or they will take shortcuts in their learning to achieve a large score.

Focus/Retention Techniques: Another app, Forest [28], is similar to a range of different apps and websites. It encourages the user to spend time off their phone, as a virtual tree will grow the less you use it, and will slowly wither away if you are on your phone for too long. There are also a plethora of tools and time management techniques to help study. Many of these can and have been done virtually but can also be conducted offline without the aid of technology. Firstly, there is the Pomodoro Method, a time management method where (usually) work is completed in cycles of 25-minute stretches with 5-minute breaks. For every 4 cycles, there is a longer break of roughly 30 minutes [29]. A common studying technique is flashcards; small cards with a hint or prompt written on the front of the card and the “answer” on the back, this encourages the student to use active recall, a successful way to achieve long-term knowledge retention [30].

There are a lot of different tools available, although they are spread across various platforms, each tackling slightly different problems. This may cause those with attention disorder to be easily distracted or overwhelmed by the plethora of tools, as there would be a lengthy setup process to simply begin working.

On the other hand, there is a lack of tools created for ADHD, which aim to capture the focus of an individual during an activity whilst promising increased retention afterwards. As previously discussed, retaining information poses a significant challenge for individuals with attention disorders.

2.2 Design Guidelines

Given the high comorbidity of ADHD with Specific Learning Difficulties (SpLDs) and mental health conditions [31], and the importance of universal design, the product's development incorporated general accessibility guidelines and practices [32].

2.2.1 HCI Guidelines

The most general and widely used Human-Computer Interaction (HCI) principles are the 10 Nielsen's Usability Heuristics [7], a rule of thumb within HCI for usable human-based products. These are listed below:

- HCI-1. Visibility of system status: The tool should be transparent to the user
- HCI-2. Match between the system and the real world: The tool's design should aim to mirror real-world design choices
- HCI-3. User control and freedom: Users should be able to navigate the tool as they choose
- HCI-4. Consistency and standards: The tool should follow a similar structure
- HCI-5. Error prevention: Error-prone aspects of the tool should not be included
- HCI-6. Recognition rather than recall: users should be able to see what they are about to do, rather than have to remember what happened last time they did something
- HCI-7. Flexibility and efficiency of use: more advanced users should be able to use the tool at a higher pace
- HCI-8. Aesthetic and minimalist design: the design should be visually appealing and uncluttered
- HCI-9. Help users recognise, diagnose, and recover from errors: users should see what errors are happening if any, and how to amend them
- HCI-10. Help and documentation: instructions and advice should be easy to find

These will be referred to throughout this paper by their ID tag (i.e. HCI-1).

Another set of rules used within this project were Gestalt's Principles [8]. Gestalt principles are perceptual rules governing how humans group and interpret visual elements. They are applied in technology design to enhance user experience by organising elements in meaningful ways, leveraging principles like proximity, similarity, closure, and continuity to create cohesive and intuitive interfaces.

2.2.2 ADHD Design Guidelines

It was vital to consider the target user during the design, therefore, due to the lack of research for design choices for adults with ADHD, an adaption of Lorna McKnight's

(2010) proposed ADHD guidelines for children was done [9]. The guidelines relevant to this project are:

- ADHD-G1. The layout needs to be neat and uncluttered
- ADHD-G2. Use calm and soothing colours
- ADHD-G3. Provide a high-reinforcement environment
- ADHD-G4. Organise items in an orderly way
- ADHD-G5. Distinguish important information by putting it in colour or bold
- ADHD-G6. Use large print (12-14pt) and a sans-serif font such as Arial
- ADHD-G7. Write/highlight alternate lines in different colours (use sparingly)
- ADHD-G8. Help pupils keep their place by marker (i.e. when doing something with multiple questions)
- ADHD-G9. Use brief and clear instructions
- ADHD-G10. Allow ample rest periods and exercise breaks
- ADHD-G11. Minimise surprises

Similarly to the HCI principles, the ADHD principles will be referred to by their ID tag (i.e. ADHD-G1).

2.3 Motivation

Research suggests that individuals with ADHD possess intellectual capabilities equal to their neurotypical counterparts [33]. However, the abundance of obstacles they encounter within educational settings can hinder these talented minds from achieving their full potential, resulting in a significant societal loss. In addition, there is a substantial cost shared by individuals, families, and society as a whole – through things such as taxes supporting public services to support people with ADHD and lost productivity. For example, in 2018, the annual social and economic cost of ADHD in Australia was estimated to reach as high as US$15,664 per person [34].

Greater investment in ADHD research, treatment, and support is crucial to mitigate this significant socioeconomic burden.

Moreover, designing academic tools for accessibility benefits not only students with disabilities but also enhances the learning experience for all students [35]. Therefore, creating a tool to aid attention focus in higher education can help mitigate the impact of ADHD and promote academic success for affected individuals, contributing to overall societal well-being.

2.4 Methodology

Therefore, this project focuses on designing a tool to support HE students with ADHD to maintain their attention focus while reading academic materials. The project followed a user-centred design approach [6], aiming to assist with the challenges identified by participants with ADHD, as well as having the user vision driving the design.

Stage 1: Background Research

The initial phase of this project involved reviewing the background research on ADHD, e-learning, and the specific challenges faced by students with ADHD within higher education environments. The research aimed to narrow in on the parts of the inattention trait might make e-learning particularly difficult for those with attention disorders. Additionally, a review of the existing tools and techniques to identify both gaps in accessibility support and potential shortcomings within current offerings. Finally, relevant design heuristics and principles were researched to make sure a user-based solution was created.

Stage 2: Pre-Design Studies

This stage consisted of semi-structured interviews with five current university students diagnosed with ADHD. These interviews aimed to build upon the insights gained in the previous section by incorporating current lived-experiences. The goals were two-fold, to try and further refine the challenge to tackle, as well as to inform the design of the user interface and experience.

Stage 3: Designing and Prototype

In this stage, a low-fidelity prototype was implemented, building upon on the data collected from the two previous stages. This initial version was then evaluated with four of the original participants and a member of the teaching staff diagnosed with ADHD. The evaluation aimed to assess the prototype's feasibility and ensure it aligned with the users' vision for the tool.

Stage 4: Implementation

At this stage, the high-fidelity prototype was implemented, informed by the feedback and design decisions gleaned from the low-fidelity prototype evaluation.

Stage 5: Evaluation

The high-fidelity prototype was evaluated in two stages: first by informatics students and staff, then by a summative evaluation involving the five participants from the initial interviews and eight experts in ADHD, accessibility, HCI, and informatics. The evaluation focused on measuring user engagement, attention, focus, and task management to gauge the proof of concept. Additionally, the evaluation also assessed the usability of the current prototype stage.

Chapter 3

Pre-Design Studies

This chapter describes the pre-design studies, which consisted of semi-structured interviews with five university students. Given the relatively sparse background research in this area, the study sought to generate insights into the challenges that HE students with ADHD encounter and what technological-based solutions would be useful to those with ADHD in higher education. This chapter aims to answer **RQ1:** *"What are the main challenges faced by students with attention disorders at university, especially in e-learning?"*.

3.1 Semi-Structured Interviews

3.1.1 Aims

The interviews aimed to identify: primary pain points that university students with ADHD face while e-learning, positive aspects of their university, tools and techniques they use in their studies, and potential technological tools that could assist them.

3.1.2 Participants

Originally, 7 current university students with ADHD were recruited to participate in the first stage of the study. However, due to scheduling conflicts, only 5 participants were interviewed. The table below (Table 3.1) gives some information about the participants.

Table 3.1: Students with ADHD

Participant No.	**Year of Study**	**Subject Area**
1	3	Environmental Sciences
2	5	Veterinary Medicine and Surgery
3	3	Philosophy and Linguistics
4	2	Computer Science
5	3	Mathematics

Selecting participants from various academic disciplines strengthens the findings on ADHD's university-wide effects. However, participants' natural tendency to focus on their own experiences may introduce a bias towards course-specific issues. To mitigate this, the research prioritises themes and experiences consistently mentioned across multiple students, potentially revealing broader university-level challenges, and giving careful thought to other points brought up. Throughout the paper, these participants will be referred to by P1…P5.

3.1.3 Procedure

Interviews were conducted online and in person, and each was audio-recorded. Virtual meetings were held via Teams [36], using the "Record and Transcribe" feature. In-person meetings were recorded using the built-in "Voice Recorder" functionality on an iPhone. Recording the meetings allowed the researcher to prioritise conducting the interview rather than taking notes. This approach was also intended to create a comfortable, informal environment for the participants, due to the potentially sensitive nature of discussing their personal life and university experiences.

Semi-structured interviews were chosen to ensure a natural conversation flow while accommodating the possibility of participants raising unanticipated, yet relevant, topics. This format offered the potential to explore emergent topics and the flexibility to return the conversation to its core focus, ensuring a comprehensive coverage of all research questions.

Each interview began with a small ice-breaker question or two. The interviewer would ask how long the participant has been in university and what they enjoy about the city they live in. The topic was then moved towards their transition between secondary and higher education, asking how they felt about the academic and lifestyle aspects. The focus shifted towards the challenges they currently face within universities and how these may have impacted their studies. Participants were asked to discuss tools and techniques they may use, and the positives and negatives of these. They were then queried what their "dream tool" may look like. The interview concluded with an optional open-ended question to suggest any specific considerations for the project. Each participant was thanked for their time and offered a copy of the interview transcript.

3.1.4 Data Collection and Analysis

Data collected comprised of audio recordings and corresponding transcriptions. In-person interview recordings were transcribed using a text editor's built-in speech-to-text functionality. Meetings via Teams were automatically transcribed during the recording. All transcripts were then manually reviewed and corrected for accuracy.

Thematic analysis (TA) was chosen as the method to evaluate the qualitative data in this study. TA is a flexible and iterative approach that allows researchers to identify, analyse, and report on emerging themes within the data [37]. The procedure involved the following steps: familiarisation with data, generating initial codes, searching for themes, reviewing themes, designing and naming themes and producing the report. The flexibility provided was particularly valuable for this project, which aimed to develop

an original solution and required openness to new ideas and the potential adaption of initial assumptions. Additionally, the time constraints of the project necessitated an efficient method. This analysis was conducted using NVivo software [38] which was chosen due to its ease of use and simple interface.

3.1.5 Results

Based on the data analysis in the previous section, the following themes were identified: Struggles and Issues, Positives at University, Tools and Techniques Used, Dream Tool and Miscellaneous.

Struggles or Issues: The data in this theme could be separated between university-specific and broader life challenges. However, the decision was made to keep it as a comprehensive theme, due to the potential for adapting strategies from general life situations to enhance academic performance and overall learning.

Participants revealed periods of inexplicable low motivation, with one participant noting, P2 mentioned *"Some days are like [...] no, I don't want to look at the work"*. Another key issue centred on content presentation. Participants expressed difficulty with lectures and readings, especially those perceived as overly factual, P1 emphasised the need for engaging delivery to maintain focus: *"They have to engage me because if not, I'm not listening. I'll be sitting in class like online shopping"*

Positives at University: Mirroring the challenges identified, participants consistently highlighted the benefits of highly engaging classes. A module's engagement could be seen through the instructor's communication style, discussion-based formats, weekly quizzes, and intrinsically interesting course topics. When being asked about one class that particularly stood out to them, P5 referred to classes that were *"collaborative [...] a very discussion-based class"* and P1 appreciated lecturers whose style is *"engaging with you [...] making you think"*.

Tools and Techniques Used: An intriguing finding emerged upon initial inquiry about study tools and techniques. While the majority of participants initially denied using any specific methods, further discussion revealed that all participants actively employed at least one approach. Participants shared that they worked best by translating the content into a format that was more suited to them. This was shown in methods such as P2's use of *"pen and paper notes"*, *"different charts and mind maps"*, and P3 asking *"ChatGPT to summarize it [...] asking like [...] can you give me a metaphor? Sometimes that doesn't work and I go. 'Can you give me an easier metaphor?' "*. P1 discussed breaking up large tasks into more manageable chunks *"If I have a 1500-word essay, I will tell myself to do 500 words a day"* Notably, a few participants mentioned that external stimuli, such as chewing gum, background music/videos, or changes in environment, enhanced their focus for extended periods.

Dream Tool: Tasked with envisioning a dream tool to address their primary academic challenges, participants engaged in a collaborative discussion with the researcher. Ideas that came up ranged widely. P2 proposed a quizzing tool to bridge assessment gaps within their courses, remarking *"sometimes assignments take too long so I think quizzes are like the perfect way of just like doing that"*. P1 and P4 favoured *"dividing*

every lecture into like smaller topics", similar to short-form content, mirroring the popular Tiktok format [39]. P5 emphasised a reward-based system, offering a treat, or monetary incentives for completing a set amount of reading *"if every single page I read I got a reward like I would definitely be way more motivated to get my reading done early"*. Finally, P3 mentioned having a tool to check the readability of their scientific visualisations, having something automatically check *"whether it's even readable cause Grammarly does that, but not really with tables and graphs"*.

Miscellaneous: This section highlights valuable insights that do not necessarily fit within one theme, but contain important considerations throughout development. As P4 emphasised, *"ADHD has so many different expressions."* Acknowledging this complexity highlights the importance of designing a flexible solution, avoiding a one-size-fits-all approach. Ongoing user feedback will be essential to ensure the tool evolves to accommodate a wider range of ADHD presentations and individual preferences. Additionally, some students revealed that they chose not to disclose their ADHD diagnosis to their university. They cited concerns about the support being inadequate to justify the time and effort felt on their part, and, in certain cases, faced the added barrier of their universities not recognising diagnoses from their home country.

3.2 Impact on Design

Through background research and focused studies, it was determined that inattention poses the most significant challenge to the academic success of students with ADHD. In academic or work settings, inattention can be divided into three stages: motivation, focus/engagement, and retention. Achieving an effective academic workflow depends on successfully addressing all three stages. The review of current tools revealed that many focus on only one stage, and while some unintentionally address two or even all three, a tool intentionally targeting all three stages would offer the most comprehensive support. Additionally, the fragmentation of resources adds another challenge for those with ADHD. Therefore, designing a tool that provides adaptive support strategies, empowering users to address their unique challenges is essential, especially given the complex and multifaceted nature of ADHD. This research highlighted the difficulties many participants experience within reading tasks, a finding supported by existing literature. Consequently, the focus shifted towards developing a tool that supports the three stages of academic workflow, specifically in the context of reading.

The following table was created to guide the design of the prototype.

Design Consideration	**Justification**
A fairly simple interface, with minimal colour and options	ADHD-G1, HCI-8
A use of neutral and calm colours	ADHD-G2
A feature to summarise the text the user is reading	Interviews
The summary feature could have a shorten/rephrase option	Interviews
A feature to create a quiz on the text	Interviews, Literature Review [40]
An ability to save one's progress and restart at a later time	ADHD-G8, Interviews
A text to speech functionality	Interviews, Literature Review
The interface appears on the page rather than another page opening	Interviews
Text styling features for increased accessibility	ADHD-G6, Interview, Literature Review [41]
A sans-serif font will be used	ADHD-G6, Literature Review [41]

Chapter 4

Low-Fidelity Prototype

This chapter describes the design and evaluation of the low-fidelity prototype for the proposed reading assistant tool. It aims to answer **RQ2** *"How can a tech-based solution be designed to help students with ADHD overcome their challenges?"*.

4.1 Design Description

The reading assistant was developed as a Google Chrome Extension to maximize accessibility and compatibility with the online reading resources used by students across disciplines. This ensures broad compatibility. Chrome Extensions will also work within the page the user is currently reading from, taking away the need for the user to switch to a different page or software. This will streamline the user experience and reduce potential distractions through minimal installation requirements. Additionally, Chrome's position as the most popular web browser [42] further enhances the tool's potential reach.

A prototype was designed in Figma [43], based on the list of requirements created in Chapter 3. Figma is a collaborative web-based tool for designing user interfaces, with the functionality to provide connections between pages and elements, simulating a realistic use of the tool without extensive development time. The realistic interface allowed an accurate assessment of the usability. Additionally, it enabled experts and students to understand the tool's functionality and provide feedback on the design choices and aesthetics.

4.1.1 Initial Appearance

The prototype simulates a PDF article opened in Chrome's default PDF reader (Figure 4.1a). A small "Reading Assistant" button appears in the top right corner of the page. It is positioned to avoid visual grouping with the browser's top bar, adhering to Gestalt's Principle of proximity [8]. The button is purple to minimise emotional connotations and ensure prominence on the page, as it is relatively uncommon in web design. A sans-serif font is used to optimise accessibility. This benefits a wide range of users, including those with dyslexia, who comprise approximately 10% of the population [41].

The prototype demonstrates a custom selection functionality by applying a light blue background to the article's abstract to simulate highlighted text. An options menu appears above this highlighted text, allowing users to interact with specific sections of the article instead of the entire document.

An article was displayed within the prototype to increase realism, the article was deliberately selected for its topical dissimilarity to the participants' fields of study. This aimed to simulate a real-world scenario in which users might apply the tool to less inherently interesting material.

4.1.2 Side Panel

Upon clicking the "Reading Assistant" pop-up, a side panel appears, resizing the rest of the page content to accommodate it (Figure 4.1b). This design draws inspiration from both Grammarly's Chrome extension within Google Docs and the inspect element functionality in Google Chrome (HCI-2). The side panel maintains a minimalistic aesthetic to avoid overwhelming the user (HCI-8), featuring limited text and colours that contrast with potentially text-heavy web pages. For navigation, each page within the side panel includes an exit icon to close the panel and a "back to reading assistant" button to return to the home page (HCI-3).

4.1.3 Quiz

The "Quiz Me!" button opens a customisable quiz setup page. Users can tailor the quiz by selecting the desired text (whole article or specific pages), choosing between open or closed-book format, and opting for multiple-choice or written answers (Figure 4.1c). Each quiz question is generated using a large language model (LLM) and manually added to the prototype to simulate the final product's functionality. Questions are presented individually to maintain focus and minimise overwhelm (Figure 4.1f). Inspired by Duolingo [27], immediate feedback is provided after each answer, with positive reinforcement for correct answers (ADHD-G3) and careful phrasing chosen to accommodate the sensitivities of users with ADHD for incorrect responses [44].

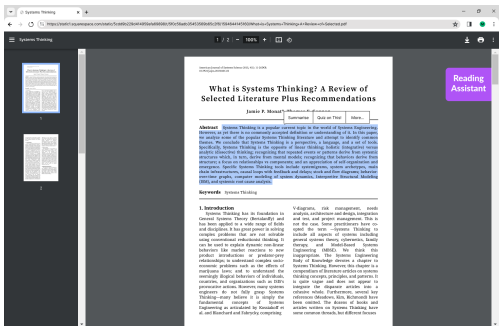
Inactive buttons are styled in grey for visual clarity (HCI-6, ADHD-G5). A "Save Progress" button is included at the bottom of the page, a feature emphasised as very important by multiple participants. While Figma's limitations prevented full implementation of this feature, its inclusion gave users an idea of what may be implemented in the high-fidelity prototype.

4.1.4 Summary

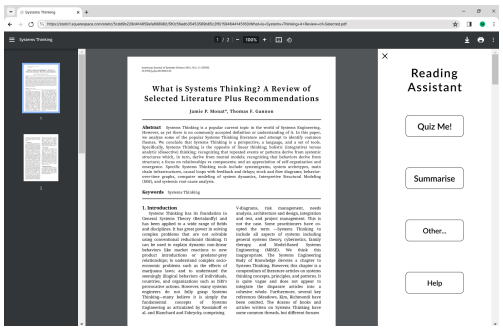
The "Summary" button opens a page with customisable options, allowing users to summarize the entire article or specific pages (Figure 4.1d). Like the quiz feature, an LLM generated summaries to provide participants with an authentic experience. After clicking the "Summarise" button, the LLM-generated summary appears. Options to rephrase or shorten the summary are provided at the bottom of the page, enhancing user control over the output.

4.1.5 Help and Other...

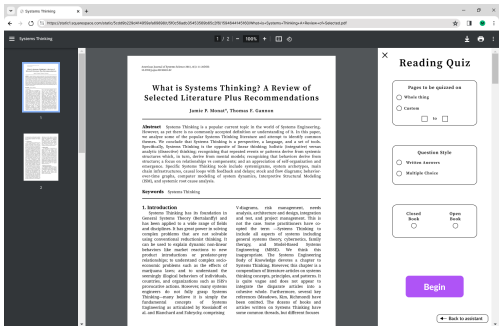
The third button, “Other,” leads to a page offering additional customization options for the webpage that the user is reading from. This sub-menu includes features for modifying the appearance of the webpage, specifically “Enable Bionic Reading”, “Enable Alternative Line Highlighting” and “Highlight Important Words/Phrases” (Figure 4.1e). The fourth button, “Help,” provides access to a dedicated FAQ section designed to assist with any common user issues.



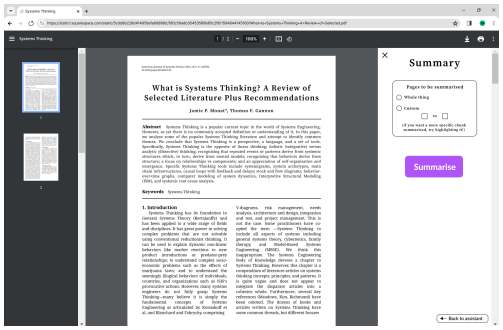
(a) Home Page



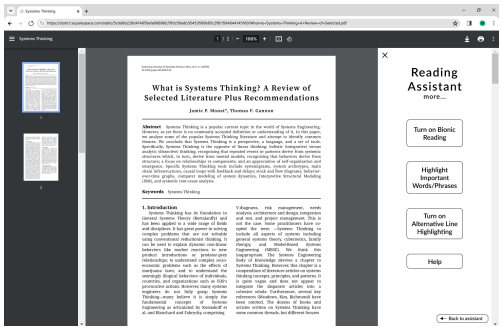
(b) Side Panel



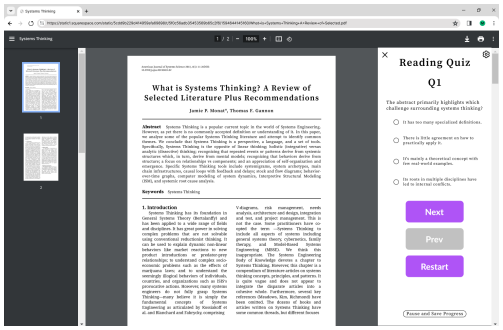
(c) Quiz Page



(d) Summary Page



(e) Other Page



(f) Quiz Question

Figure 4.1: Low Fidelity Prototype Screenshots

4.2 Concept Evaluation and Usability Testing

4.2.1 Aims

The aims of this study are as follows: identifying usability problems, gathering feedback regarding users’ experience and preferences while interacting with the tool, and

gathering suggestions to improve the tool, including new features.

4.2.2 Participants

The participants were the same as in Table 3.1, excluding P3 due to scheduling conflicts. Additionally, through a project presentation, a teaching staff member with ADHD was recruited as an expert.

4.2.3 Methods and Procedure

Evaluations were primarily conducted remotely via Teams, with one conducted in person. Screen recording was employed throughout. For the in-person session, OBS software [45] was used to capture the screen, mouse movements, and audio. The virtually attending participants were provided a link to the Figma prototype and encouraged to share their screens.

All participants were instructed to use the think-aloud process [46] to verbalise their thoughts while interacting with the prototype. This method was chosen to gain insights into participants' thought processes behind their actions, giving a good idea about the usability of the prototype. However, concerns about continuous verbalisation alongside task completion were raised by participants. Additionally, the straightforward design limited opportunities for extensive commentary. Therefore, a follow-up semi-structured interview was designed to ensure comprehensive feedback.

Participants were required to perform four tasks that aimed to give them a comprehensive understanding of the prototype. They were to have the prototype create summaries of the abstract and whole document, as well as try out the quiz functionality.

At the end, the user was invited to a brief interview. The questions were meant to elicit what they like most and least about the extension, what they would remove or change, and what suggestions they have to improve it. Additionally, they were asked if they would like to use the extension and to provide a justification of their answer.

4.2.4 Data Collection and Analysis

The data collected from this study consisted of video recordings of the users' actions within the prototype, audio recording of the study and transcriptions of the study. Given the ongoing high-fidelity prototype development, a brief thematic analysis was conducted to ensure the changes aligned with the users.

4.2.5 Results

The top-down approach of Thematic Analysis was employed with a set of pre-defined themes: "Positives", "Negatives", and "Wants".

Positives: The positives included the simplicity of the tool, with the expert mentioning *"very straightforward to understand . . . how to do things"*. Additionally, the functional-

ities were well received overall, with P2 stating *"I like the summary I think it's very useful"* and how it was *"nice to be able to quiz myself"*.

Negatives: Some negatives included participants being unsure how much they trust features, the expert mentioned they were *"a little bit sceptical of the summary function"*. Each participant expressed general confusion over some features in the Other... section, P1 asked *"what is bionic reading?"* and P4 questioned *"what would alternative line highlighting do?"*. An additional negative was the lack of sureness in the *"highlight important phrases and words"* functionality, P2 remarked *"I feel like, that's kind of subjective as to what's important"*

Wants: The most requested features appearing in the Wants categories were accessibility-focused, the expert requested a *"full line cursor"*, P1 and P4 both asked for *"text-to-speech"* and P2 suggested being able to *"change the background colour, as [...] it's helpful for dyslexia"*.

4.3 Concept and Design Revisions

Overall, participants responded positively to the concept, envisioning various use cases that would benefit their university studies. However, as addressed in the previous section, user feedback highlighted specific issues and concerns that motivated subsequent design revisions.

Firstly, the ambiguous "Other..." label led to confusion and under-utilisation of the feature. It was replaced with the more descriptive "Alter Webpage". Participant suggestions were incorporated, adding background colour customisation, along with font and font-size options, for improved accessibility. Features like "Bionic Reading", "Alternative Line Highlighting" and "Highlight Key Words/Phrases" were removed due to user unfamiliarity and a lack of trust in automated selection. These features remain under consideration for future work.

The "shorten" and "rephrase" summary options were removed due to expert feedback highlighting potential learning limitations. The expert, providing an educator's perspective, emphasised the importance of manually extracting summaries directly from the source material. While these features could be useful for initial engagement, they were deemed potentially detrimental to long-term knowledge acquisition.

The remaining accessibility suggestions from the 'Wants' category will be addressed in future iterations of the tool.

Chapter 5

Working Prototype

This chapter describes the high-fidelity prototype implementation of the tool based on the work done so far. It aims to continue answering **RQ2:** *"How can a tech-based solution be designed to help students with ADHD overcome their challenges?"*

5.1 Software and Resources

5.1.1 Technical Decisions

The tool was designed as a Google Chrome Extension, as decided in the low-fidelity prototype. To create the Chrome Extension, JavaScript was the primarily used language, additionally, CSS and HTML were used as these are the most popular languages for web development, matching the language of the Chrome Extension Development tutorials [47]. For the LLM used to create summaries and quizzes, GPT3.5-turbo-0125 [48] was selected due to its low cost, availability and ease of setup and use. The use of JavaScript allowed HTML and CSS to be injected into target webpages, to create the "Reading Assistant" button, and it also enabled communication between the GPT3.5 API and the extension. A small amount of prompt engineering was also incorporated to try to have the output from the LLM be created in such a way that it could be altered and displayed by the JavaScript and HTML. To create the side panel, Google Chrome's "Side Panel" [49] technology was adopted. This created a pseudo "website" that could be run alongside the webpage being used, allowing for communication between the website and the side panel, as well as full creative freedom of the design and contents.

5.2 High Fidelity Prototype Description

The initial look of the Reading Assistant pop-out stayed relatively similar to the prototype, with the addition of two buttons (Figure 5.1a). The button attached to the left of the Reading Assistant button allowed the user to hide the Reading Assistant button, in case it was taking up too much space on the page, the same button could be clicked to display the Reading Assistant again. There was a small change from the prototype, where the "Alter Page" menu had to be moved from within the side panel to the webpage

it was altering, this menu is initially hidden behind a down arrow underneath the reading assistant button.

When the "Reading Assistant" button is clicked, the side panel appears, similar to the prototype, now only containing 3 buttons; "Quiz Me!", "Summary" and "Help" (Figure 5.1b). A small change from the prototype was the addition of a top heading bar within the side panel. This heading bar contained a colour palette icon, displaying a list of colours for the user if they wanted to change the background of the reading assistant, and a button with "A+" and "A-" which enables the user to increase or decrease the font size within the side panel. The heading bar within Google Chrome's default side panel under "Reading Mode" inspired this appearance and functionality.

To get the text from the webpage, the JavaScript scanned all the HTML elements and checked for an "Article" tag. If this was found, the inner text from the article was stored, later to be sent to the GPT API.

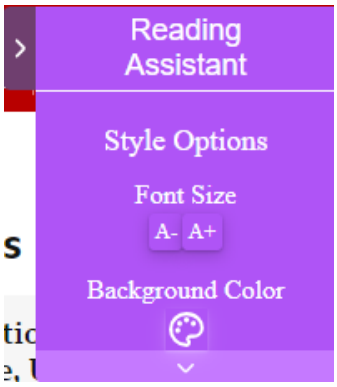
Quiz: Upon clicking on the quiz, the user would be met with "Please wait, content loading..." as there would be a small delay while the text underwent quiz generation, communication with the JavaScript backend, HTML conversion, and display (Figure 5.1f). This quiz generation was made possible through an iterative development process using GPT's Playground [50]. This web-based interface enabled direct interaction with the LLM engine. Text from a chosen source could be directly copied and pasted, accompanied by prompts instructing the model to create multiple-choice questions. GPT's Playground provided the flexibility to experiment with parameters such as temperature and output length, fine-tuning the results for the desired quiz format, without having to implement it in code until it was refined.

Summary: The functionality behind the Summary was nearly identical to the quiz function, with the main difference being within the prompt. The prompt required considerably less fine-tuning as it is quite a frequent functionality of LLMs and was less complex than the quiz. The LLM will generally produce a small summary paragraph, followed by several "key points" displayed as bullet points using "+" characters to be translated into HTML bullet points (Figure 5.1d).

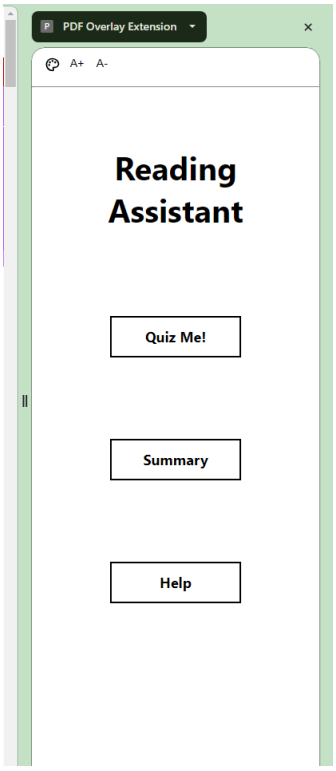
Help: The Help page contained three short FAQs "How to get a summary of the webpage I'm looking at", "How does the summary/quiz work?" and "How do I change the colour of the website" (Figure 5.1e). These were created based on the main problems that came up during the low-fidelity prototype evaluation.

Alter Page: Similar to the header within the side panel, the "Alter Page" screen contains styling options to change the font size and background colour of the webpage that the user is viewing (Figure 5.1a). The colours were carefully selected as they were optimal for contrast and reading for those with dyslexia [51].

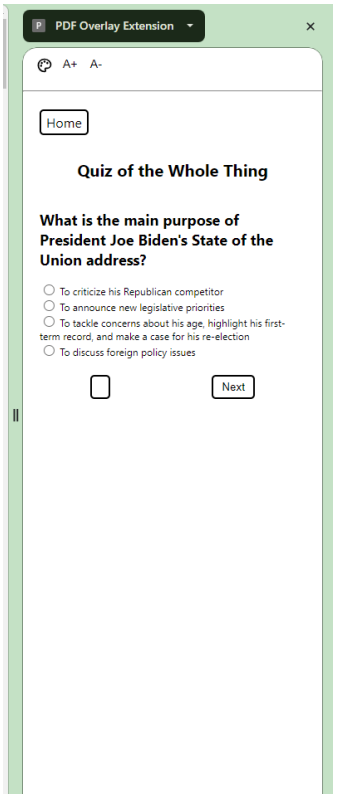
The three buttons on the home page were created using div elements instead of button elements, as this gave more freedom for CSS styling. Importantly, this meant that the "tab-index" functionality of CSS needed to be implemented to allow people who may not be able to use a mouse to still access the buttons.



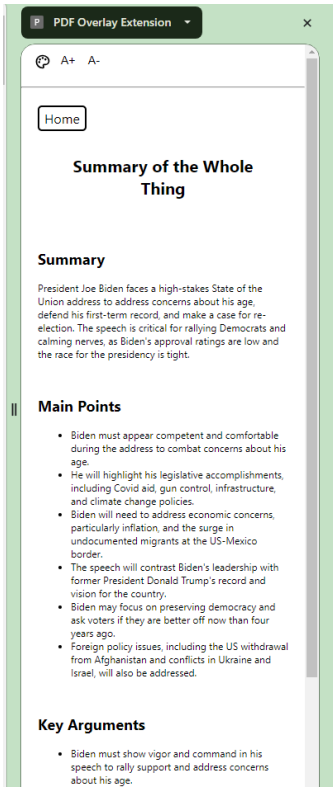
(a) Alter Page Menu



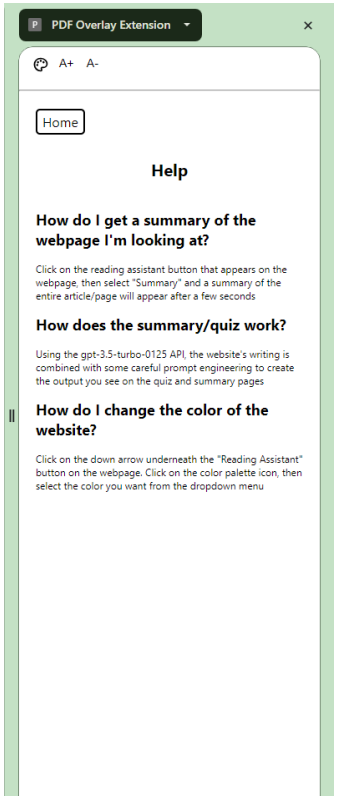
(b) Side Panel HFP



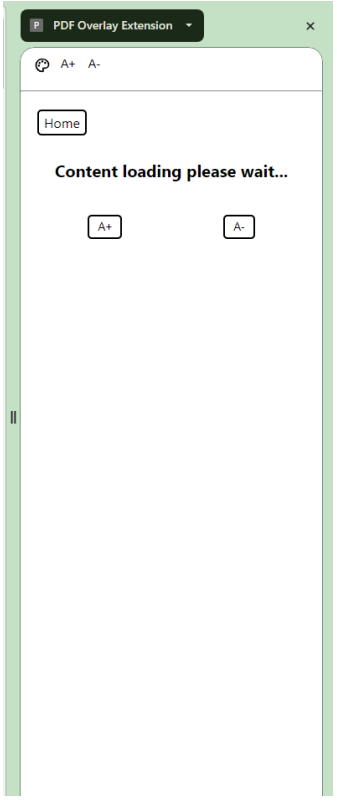
(c) Quiz Question HFP



(d) Summary Page HFP



(e) Help Page HFP



(f) Content Loading HFP

Figure 5.1: High Fidelity Prototype Screenshots

Chapter 6

Evaluation

This chapter presents the two evaluation studies of the high-fidelity prototype: a usability study with University students and staff members, and a summative evaluation with five students with ADHD and eight experts in ADHD, Informatics, HCI, and accessibility. It aims to answer **RQ3:** *"How effective is the tool in aiding users with ADHD in university?"*.

6.1 Initial Usability Study

The Chrome Extension was first evaluated by Informatics students and staff of the University of Edinburgh during Project Day. This study was widened by conducting it with friends and family members of the researcher, all of whom are current university students or staff members.

6.1.1 Aims

This study aimed to evaluate the usability of the Chrome Extension, as well as try to evaluate the feasibility of the concept.

6.1.2 Participants

Through the Project Day and contacts of the primary researcher, 23 people participated in the study, all of whom were current university staff members or students of universities in Scotland. The study ensured participant anonymity. Since open-ended questions were optional, the numerical ID assigned to each response does not necessarily correspond to the same participant across all questions within the online form.

6.1.3 Methods and Procedure

The participants attended the Project Day in-person on campus, then were able to read the project poster, ask questions about the project, and watch a demonstration of the Chrome Extension working on a news article.

The choice was made for a demonstration format rather than hands-on trials to accommodate larger participant groups and late joiners. After watching the demo and having the opportunity to ask questions or try functionalities, participants completed an online System Usability Scale (SUS) questionnaire using Microsoft Forms [53]. The SUS is a well-regarded usability evaluation tool, consisting of ten short statements alternating between positive and negative statements about the system's ease of use and learnability [54]. Participants respond on a five-point Likert scale ranging from strongly disagree to strongly agree (Appendix E). The SUS score is then calculated to provide a single value from 0 to 100, with higher scores reflecting greater perceived usability. An average SUS score is around 68 (indicated by the red arrow), with scores above 73 generally considered indicative of good system usability (see Figure 6.1). To expand the research, the Chrome Extension was also briefly demonstrated to university members and staff outside the Informatics department, who were then invited to try the extension, ask questions, and complete the SUS questionnaire.

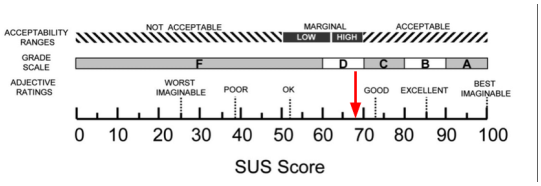


Figure 6.1: Comparative illustration of adjective ratings, acceptability scores, school grading scored and the overall SUS scores (Bangor et al. 2009 [52])

6.1.4 Data Collection and Analysis

The data collected were the scores from the SUS questionnaires, and the open-ended question answers.

6.1.5 Results

The score of each participant can be seen in figure 6.2. The scores ranged between 72.5 and 97.5, with an average of 87.95, indicating a very high usability. One of the scores was removed from the data due to it seeming non-genuine, the participant clicked disagree and strongly disagree for each question, which the SUS questionnaire's style counters, by alternating between positively and negatively themed questions ensuring that if participants genuinely disliked the tool, they'd alternate between disagree and agree. Furthermore, the participant left no additional comments, and their review took under 1 minute, while the average was 5 minutes long. The open-ended questions gave some overall feedback on the prototype.

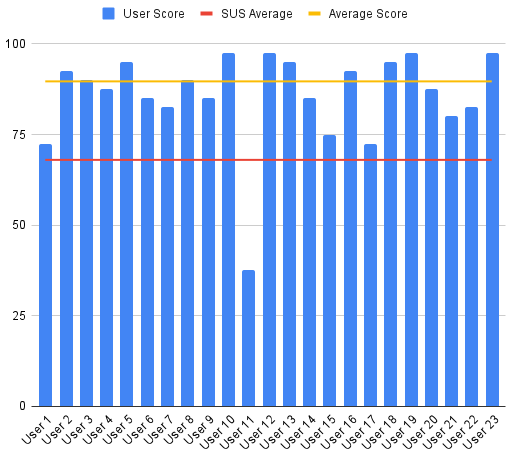


Figure 6.2: SUS results from Project Day and friends/family of the researcher

Positives: Participants expressed appreci-
ation for various features. The quiz functionality was particularly popular, with one commenting that they *"would definitely use it in day-to-day Uni work."* Others favoured the summary feature, including a staff member who found it *"fantastic"* and saw potential benefits for lecturers. The tool's usability was also praised, with participants describing it as *"quick and easy to use"* and *"simple and integrated."* Customisation options like colour and text size adjustments were also valued by users.

Negatives: Participants were unhappy with the current reach of functionality, specifically noting the inability to scan PDFs, with one user commenting: *"the fact it can't scan PDFs"* was their least favourite aspect. Some usability concerns were raised, including feedback on the small size of buttons within the purple pop-out and broader comments about the overall layout and design.

Improvements: Participants' suggestions for improvements directly addressed the earlier feedback. Top priorities included support for PDFs, images, and unstructured text formats, reflecting the desire for broader functionality. Additionally, there were numerous calls for enhancements to the user experience and design, with participants specifically mentioning *"bigger/clearer buttons," "more user-friendly buttons,"* and improvements to the *"quiz UI."*

Design Choices: While most participants expressed satisfaction with the visual design, with many simply responding "no" when asked about which elements they disliked, some suggestions for improvement emerged. Specific feedback included finding the colour-change button too small and a sense of *"too much empty space"* within the interface.

It is important to acknowledge that the majority of participants were recruited from the Project Day, ensuring a largely unbiased sample. However, some positive bias may exist within the researcher's contacts, and this should be considered when interpreting the results.

6.2 Summative Evaluation

6.2.1 Aims

The main purpose was to find out to what extent the tool is effective in helping students with ADHD to achieve an effective academic work flow. To evaluate this, the following aspects are assessed: usability, the engagement of students with ADHD, to what extent the tool targets the effective academic workflow, and other gains the students have from using this extension.

6.2.2 Participants

The participants were the same five university students from the initial pre-design study shown in Table 3.1 and eight experts listed in Table 6.1.

Expert No.	Expertise
1	Teaching Staff Member with ADHD
2	Applied Machine Learning and Artificial Intelligence
3	User Experience / HCI
4	User Experience / HCI
5	User Experience / HCI
6	Accessibility Support Lead
7	Accessibility Support Team
8	Accessibility Support Team

Table 6.1: Experts

6.2.3 Procedure

All but two of the evaluations were conducted virtually via Microsoft Teams [36]. Any experts who had not completed a study for this project were asked to fill out a Participant Information Sheet and Consent Form before the meeting. Evaluations were done with either one or three experts at a time and one-on-one with the students, lasting between 20 and 50 minutes.

The evaluations began with a quick overview of the tool and what it was supposed to achieve, with a small explanation of the questions and tasks that they were going to be asked to complete. The tool was run on the researcher's laptop, with the screen shared, so the participant would be more obliged to think aloud as they would need to verbalise steps they would have taken if they were in control. Rather than using a Think Aloud method, this study utilised a Cooperative Evaluation, an adaptation of Think Aloud [55]. During the Cooperative Evaluation, the researcher encouraged participants to ask clarifying questions and could interrupt them to request they explain the reasoning behind their actions/choices. This allowed the researcher to gather more insights into the participants' struggles, issues, and positive experiences with the tool.

The participants were asked to complete three tasks, which would give them an extensive understanding of the tool and its functionalities in its current stage of development. The tasks were as follows:

- Task 1: Find a website (preferably a BBC article) and use the reading tool to get a summary of the article.
- Task 2: Change the background colour of the website and the reading assistant to peach
- Task 3: On the website, have a quiz created, and go through and complete 5 questions from it.

Following the tasks, participants were asked six questions using a Likert scale on different factors that were deemed important to gather an understanding of how the tool was received. These were: Enjoyment, Engagement, Efficiency, Motivation, and Focus. They were then asked to fill out the SUS questionnaire used in the initial evaluation, with a new one created to avoid mixing the data. Finally, they were asked two short

questions in a semi-structured interview style as these were important for the context of the project and what scope it should be developed for if it needed further development. The questions were “What are some things you would use this tool for?” and “Do you think there’s a risk of taking away from the user’s learning by using this tool?”.

6.2.4 Data Collection and Analysis

The results from the recordings were transcribed and combined with notes taken by the researcher during the evaluations and the open-ended questions within the questionnaire. Similar to the low-fidelity prototype, a thematic analysis was conducted to collect and analyse the data. Additionally, the SUS questionnaire scores were taken and processed using the formula to assess the usability.

6.2.5 Results

The scores from the SUS questionnaire averaged 82.88, again displaying very high usability. The lowest score was 77.5 and the highest was 95. Notably, the score is lower than the one given in the previous study. This is likely because there were considerably more experts involved in the process this time, who would have more knowledge of what sort of things to look for and where the prototype might be lacking. Additionally, getting a full experience of using the tool for a longer period than the participants would have had on the project day, would allow them to have a better overall familiarity of the product. The scores of each participant are displayed in Figure 6.3.

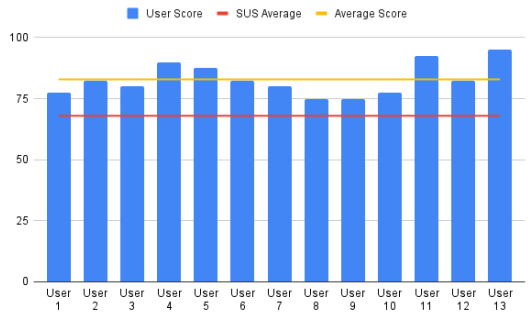


Figure 6.3: SUS results from students and experts

The thematic analysis ended up with eight themes:

Usability: This theme underscores the Chrome Extension’s strong usability, evident in both the high SUS scores and the positive feedback gathered. E3 appreciated its simplicity and customizability, stating: *“it’s useful and simple and I like being able to customise things.”* Experts also valued the tool’s seamless integration within the webpage. E6 commented: *“I found the quick availability of it on the page (side panel on edge) alongside the article in one view very handy”* Similarly, E7 highlighted the ease of use and low barrier to entry, stating: *“The fact that it seems very easy to get started with, quick and intuitive to use”*

Engagement: The tool’s quiz functionality proved to be a key driver of engagement. Participant E7 explicitly praised this aspect, stating: *“because of the quiz element I am more engaged with it”* Beyond this specific feature, participants also felt that the tool enhanced their overall reading experience. P2 commented: *“It was a really interesting*

way to engage me with the whole reading process" These testimonials highlight how the tool creates a more interactive approach to academic reading.

Support with attention/focus: The tool's potential to address challenges with focus was a strong finding. E1 noted that during moments when their students with ADHD are *"not able to absorb anything on the page"* the tool *"would be a good way to break that pattern."* Participants also found that specific functionalities like the quiz and summary features were instrumental in capturing and maintaining their attention. P4 emphasised this point, commenting: *"The summary and quiz function keep me focused on task"* Similarly, E1 perceived the summary feature as providing *"some expected anchors"* for the material. This could help alleviate the sense of being overwhelmed by unfamiliar or complex articles, further supporting sustained focus and attention.

Efficiency: This theme underscores the potential for increased productivity and efficiency that participants and experts envisioned with the tool's proper integration into their workflow. E8 emphasised this point, noting that *"if you had a large volume of reading, then I think it would probably help you to be productive and kind of keep you on task"*. Participants appreciated the ability to focus on essential information. E3 commented, *"it's cutting out information I don't need, and of course, if it was necessary, I would just go and read the article"* This targeted approach aligns with P5's observation that the tool *"decreases the amount of time and energy going into doing work"* Additionally, P2 expressed that *"it would help me understand things a lot faster"* further highlighting the potential for improved efficiency. E5 affirmed this sentiment, stating that the tool enables tasks to be completed more quickly.

Motivation: This theme highlights the tool's potential to enhance motivation. Participants observed that it could be especially helpful for those who find reading unappealing. P3 emphasised this, noting, *"I know it'll benefit a lot of people who don't enjoy their reading."* Additionally, the tool's immediate feedback feature resonated with participants as a motivating factor. As P2 expressed, *"the immediate feedback you get, is motivation within itself"*. These insights suggest that the tool may help students with ADHD overcome motivational hurdles and engage more fully with reading-intensive tasks.

Tool Limitations: This theme highlights the tool's inherent limitations and flaws in its current design. Users noted that screen reading is never their preferred option, as evidenced by E6's comment: *"If I have to read something, I'll print it out."* Some participants found it took longer to read with the tool, as E7 mentioned: "I would probably say it took me longer to read." Design issues were also raised, including the small text size and indistinct button icons, as mentioned by E4: *"All the text being small [...] was problematic"* and *"the icons are not standing out."* Additionally, users expressed scepticism about the summary and quizzing features, bringing up concerns about accuracy and potential for misrepresenting the source material, with a few stating *"they would not trust it"* as E5 mentioned *"there's a risk it summarises wrongly."*

Suggestions for further work: This theme captured both fixable limitations and potential areas for future development. Users envisioned greater customisation options, including the ability to change how text was displayed further, P3 suggested being able to alter *"font type and letter spacing"* for improved readability. Drawing inspiration

from popular applications, P4 suggested adopting *"in apps like Duolingo, it's a larger box you select"* for quiz answers, offering a more intuitive user experience. To increase engagement, E2 proposed adding prompts after summaries, allowing users to *"have a prompt there after the first summary"* giving the option to bounce ideas and thoughts off the reading assistant. Additionally, it became apparent that many users perceived the tool as a potential replacement for engaging with the material directly. They expressed sentiments like E7's *"I'd still want to read the article myself"*. This underscores the need to refine how the tool is communicated to users, emphasising that it's designed to aid their reading and focus, rather than serve as a shortcut to avoid the work altogether.

Participants also rated the tool's potential impact on various factors: enjoyability, engagement, efficiency, productivity, motivation, and focus. Using a 5-point Likert scale, they provided responses that are visualised in Figure 6.4. Results indicate that the tool aligns with the initial two stages of an effective academic workflow. Specifically, the average motivation score of 3.81 suggests that users found the tool would increase their motivation to do academic work. Additionally, the engagement score (3.58) and focus score (3.77) indicate potential improvements in attention during tasks. While the impact on the final stage (retention) could not be measured reliably with this method, future work involving quantitative testing is recommended to assess this aspect.

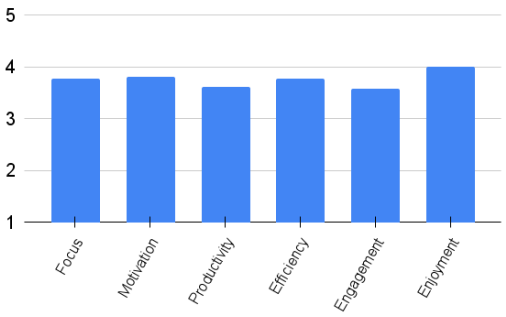


Figure 6.4: Average score of the Likert score ratings for the factors

Given the positive reception from participants and experts, the tool's high usability scores, and its demonstrated support for all three stages of an effective academic workflow, the tool appears to be highly successful in aiding students with ADHD within higher education e-learning environments.

Chapter 7

Discussion, Conclusion and Future Work

7.1 Research Questions

RQ1: What are the main challenges faced by students with attention disorders at university, especially in e-learning?
This question was answered through a literature review and a round of semi-structured interviews with current university students diagnosed with ADHD, as reported in chapters 2 and 3. The background chapter outlined the lack of support for those with ADHD, especially past childhood, with an additional lack of e-learning support. This was reinforced by the interviews with the students, where one praised the topic as they felt there "isn't much support for ADHD". The research and studies pointed out that there was not much to assist those with ADHD to prove their focus and attention had been fruitful, and that there was too much of a spread between the different tools, requiring the student to find out about and use multiple different tools in their studies and daily life. The combination of these helped narrow the focus of the project towards tackling the challenge of facilitating an effective academic workflow.

RQ2: How can a tech-based solution be designed to help students with ADHD overcome their challenges?
To answer this question, further studies were carried out, including a think-aloud study on the low-fidelity prototype and a thematic analysis of its results. A decision was made to create a reading assistant that would help with all three stages of academic workflow, capturing a diverse spread of what was discovered in the research and pre-design studies. A low-fidelity prototype was created to see if it would be something that could assist with their e-learning difficulties.

RQ3: How effective is the tool in aiding users with ADHD in university?
This question was answered through the qualitative data collected through numerous stages of interviews and evaluations. The Chrome Extension was well-received in subsequent studies involving five participants with ADHD and eight experts specializing in Informatics, ADHD, Accessibility, and User Design/Experience. These studies demonstrated a range of uses for it in its current prototype state, revealing a very high

potential for this product.

7.2 Limitations

Due to the project's time constraints, the Chrome Extension development focused on establishing a proof of concept rather than a perfected product. While the core functionality was realised, several valuable suggestions from the iterative design process remain unimplemented or require further exploration. A key area for future work is enabling PDF compatibility to address this common format's accessibility challenges.

The use of a low-budget GPT model resulted in limitations regarding the quality of output and input handling. Investing in a more advanced model could enhance user experience and reduce potential mistrust stemming from limitations in the current model's capabilities.

The small participant sample and short-term nature of this project limit the ability to draw definitive conclusions about the tool's effectiveness. A long-term study with a larger participant pool would provide more robust evidence about the tool's effectiveness, particularly in aiding those with ADHD in the retention stage of academic workflow. While existing research supports the tool's potential in this area, future research involving real-life testing is crucial for verification.

Despite these limitations, evaluation by participants indicated the tool's concept has significant potential. Positive user feedback included suggestions for potential commercialisation, highlighting the tool's promise as a valuable solution for individuals with ADHD.

7.3 Future Work

The following refinements and implementations are suggested as a starting point for future development to ensure the reading assistant achieves its maximum potential.

User Experience: Firstly, clear communication is crucial. The tool's purpose as a reading aid rather than a replacement must be displayed, this can be done via a detailed description in the Chrome Extension store, or frequent messages within the user interface. Given the promising research on gamified learning, future development should explore integrating gamification elements throughout the reading assistant, beyond the existing quiz functionality. This could enhance support across all three stages of the academic workflow, particularly addressing initial motivation.

Accessibility and Design Changes: Due to its nature as an accessibility tool, future developmental work should strive to maximise accessibility, putting those with ADHD first, yet aiming to create no barriers for other users. To achieve this, the tool offers customisation options such as adjustable font family and size, with a larger default font for improved readability. Text-to-speech functionality for both the tool and webpage should also be explored, as this feature has a strong user interest. Addressing an issue shared by numerous users in the evaluation, a clear differentiation between the buttons

for opening the reading assistant and altering the webpage styling will be a high priority. Finally, a feature within the "Alter Webpage" section should be designed to remove distractions like images and ads from articles, allowing users to focus purely on the text content.

Technical Implementations: A top priority for future technical development is establishing support for PDFs. Accessibility experts highlighted the limitations of PDFs during the summative evaluation. By enabling features like text spacing adjustment, font size modification, and background colour changes, the tool can significantly benefit users with ADHD and diverse accessibility needs. This functionality is important as PDFs are a prevalent format for articles and student reading assignments.

To maximise accuracy and consistency, a higher-quality LLM should be considered. To avoid the challenge of receiving funding, the current implementation utilises a low-cost model. Refined prompt engineering would also be beneficial, as it may reduce costs and improve the consistency of the output. An additional functionality would be to re-introduce the highlighting and custom text selection proposed during the low-fidelity prototype stage, as this would significantly increase the tool's adaptability.

Evaluation Methods: A long-term evaluation is essential to gather statistical and objective evidence of the tool's ability to improve accessibility and support users with ADHD. This study would measure metrics like reading efficiency and comprehension, comparing those who use the tool against those who rely on their usual reading methods. As one participant pointed out, ADHD manifests diversely across individuals, emphasising the need for ongoing collaboration with those with ADHD. A larger sample size in future evaluations would ensure a broader range of experiences is considered, leading to a tool with wider accessibility benefits.

7.4 Conclusion

This project investigated ADHD and the current landscape of accessible tools created to support those with the condition with e-learning in HE. Analysis revealed a gap: while many tools exist, few intentionally target all three stages of the academic workflow for individuals with ADHD – motivation, engagement, and retention. To address this underserved need, a new tool was proposed.

The development process prioritised user-centred design through an iterative approach. The researcher worked closely with students with ADHD and alongside experts in ADHD, accessibility, and user experience. The development resulted in the creation of a "Reading Assistant" in the form of a Google Chrome Extension. This tool aimed to assist those with ADHD in the pre-reading, during reading and post-reading focus levels, via a summary feature, quiz feature, and style changing functionalities. This collaborative effort ensured that the extension was meticulously designed around the specific needs and challenges faced by users with ADHD. Based on the evaluation studies, the Google Chrome Extension created shows promise as a valuable tool that could be appropriate and helpful for individuals with ADHD.

The contributions to the research are as follows: 1. Identification of the challenges

encountered by HE students with ADHD. 2. A prototype of a reading assistant to help HE students with ADHD focus on their online reading. 3. Empirical data from the evaluation with students and experts in ADHD and accessibility, which reveals that the tool is promising for helping students with the three different stagess of an effective academic workflow.

Bibliography

[1] A. P. Association, *Diagnostic and Statistical Manual of Mental Disorders*, 5th ed. American Psychiatric Association Publishing, 3 2022, vol. DSM-5-TR.

[2] M. S. Daffner[1], G. J. Dupaul[1], A. D. Anastopoulos[2], and L. L. Weyandt[3], "From orientation to graduation: Predictors of academic success for freshmen with adhd," p. 113.

[3] R. A. Rivas-Vazquez, S. G. Diaz, M. M. Visser, and A. A. Rivas-Vazquez, "Adult adhd: Underdiagnosis of a treatable condition," *Journal of health service psychology*, vol. 49, no. 1, pp. 11–19, 2023.

[4] J. Kooij, D. Bijlenga, L. Salerno, R. Jaeschke, I. Bitter, J. Balázs, J. Thome, G. Dom, S. Kasper, C. Nunes Filipe, and et al., "Updated european consensus statement on diagnosis and treatment of adult adhd," *European Psychiatry*, vol. 56, no. 1, p. 14–34, 2019.

[5] S. Young, P. Asherson, T. Lloyd, M. Absoud, M. Arif, W. A. Colley, S. Cortese, S. Cubbin, N. Doyle, S. D. Morua *et al.*, "Failure of healthcare provision for attention-deficit/hyperactivity disorder in the united kingdom: a consensus statement," *Frontiers in psychiatry*, vol. 12, p. 649399, 2021.

[6] C. Abras, D. Maloney-Krichmar, J. Preece *et al.*, "User-centered design," *Bainbridge, W. Encyclopedia of Human-Computer Interaction. Thousand Oaks: Sage Publications*, vol. 37, no. 4, pp. 445–456, 2004.

[7] J. Nielsen, "Heuristic evaluation ten usability heuristics," 2005.

[8] D. Todorovic, "Gestalt principles," *Scholarpedia*, vol. 3, p. 5345, 2008.

[9] L. Mcknight, "Designing for adhd: in search of guidelines."

[10] E. Cormier, "Attention deficit/hyperactivity disorder: A review and update," pp. 345–357, 10 2008.

[11] R. A. Barkley, "Myth: All children grow out of adhd," 2019.

[12] S. Young, "The persistence of adhd into adulthood," 2001.

[13] Oct 2023. [Online]. Available: https://www.cdc.gov/ncbddd/adhd/data.html

[14] K. Sayal, V. Prasad, D. Daley, T. Ford, and D. Coghill, "Adhd in children and young people: prevalence, care pathways, and service provision," *The*

Lancet Psychiatry, vol. 5, no. 2, pp. 175–186, 2018. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2215036617301670

[15] A. Parker and P. Corkum, "Adhd diagnosis: as simple as administering a questionnaire or a complex diagnostic process?" *Journal of attention disorders*, vol. 20, no. 6, pp. 478–486, 2016.

[16] J. A. Sedgwick-Müller, U. Müller-Sedgwick, M. Adamou, M. Catani, R. Champ, G. Gudjónsson, D. Hank, M. Pitts, S. Young, and P. Asherson, "University students with attention deficit hyperactivity disorder (adhd): a consensus statement from the uk adult adhd network (ukaan)," *BMC Psychiatry*, vol. 22, 12 2022.

[17] M. A. Fauzi, "E-learning in higher education institutions during covid-19 pandemic: current and future trends through bibliometric analysis," *Heliyon*, vol. 8, no. 5, 2022.

[18] B. M. Amarneh, M. T. Alshurideh, B. H. A. Kurdi, and Z. Obeidat, "The impact of covid-19 on e-learning: Advantages and challenges," pp. 95–108, 2021. [Online]. Available: http://www.springer.com/series/11156

[19] N. Geri, A. Winer, and B. Zaks, "Challenging the six-minute myth of online video lectures: Can interactivity expand the attention span of learners?" 2017, how adding interactivity to lecture videos was shown to increase the watch time and completion rate of the audience.

[20] C. L. Friel, "Experiences of students with attention deficit/hyperactivity disorder (adhd) in online learning environments: a multi-case study," Ph.D. dissertation, University of Missouri–Columbia, 2022.

[21] G. Ben-Yehudah and A. Brann, "Pay attention to digital text: The impact of the media on text comprehension and self-monitoring in higher-education students with adhd," *Research in Developmental Disabilities*, vol. 89, pp. 120–129, 6 2019.

[22] W. N. Amorim and S. C. Marques, "Inhibitory control and cognitive flexibility in children with attention-deficit/hyperactivity disorder." *Psychology & Neuroscience*, vol. 11, no. 4, p. 364, 2018.

[23] T. E. Brown, *Outside the box: rethinking ADD/ADHD in children and adults: a practical guide*. American Psychiatric Pub, 2017.

[24] "Spreeder." [Online]. Available: https://www.spreeder.com/

[25] [Online]. Available: https://bionic-reading.com/

[26] "Fabulous! motivate me." [Online]. Available: https://www.thefabulous.co/

[27] "Duolingo." [Online]. Available: https://www.duolingo.com/

[28] "Forest." [Online]. Available: https://www.forestapp.cc/

[29] F. Cirillo, *The Pomodoro technique: The acclaimed time-management system that has transformed how we work*. Currency, 2018.

[30] P. C. Brown, H. L. R. III, and M. A. McDaniel, *Make It Stick*. Cambridge, MA and London, England: Harvard University Press, 2014. [Online]. Available: https://doi.org/10.4159/9780674419377

[31] M. A. Katzman, T. S. Bilkey, P. R. Chokka, A. Fallu, and L. J. Klassen, "Adult adhd and comorbid disorders: clinical implications of a dimensional approach," *BMC psychiatry*, vol. 17, pp. 1–15, 2017.

[32] [Online]. Available: https://www.w3.org/TR/WCAG22/

[33] T. E. Brown, *Smart but stuck: Emotions in teens and adults with ADHD*. John Wiley & Sons, 2014.

[34] E. Sciberras, J. Streatfeild, T. Ceccato, L. Pezzullo, J. G. Scott, C. M. Middeldorp, P. Hutchins, R. Paterson, M. A. Bellgrove, and D. Coghill, "Social and economic costs of attention-deficit/hyperactivity disorder across the lifespan," *Journal of attention disorders*, vol. 26, no. 1, pp. 72–87, 2022.

[35] T. Joosten and R. Cusatis, "A cross-institutional study of instructional characteristics and student outcomes: Are quality indicators of online courses able to predict student success?." *Online Learning*, vol. 23, no. 4, pp. 354–378, 2019.

[36] "Teams." [Online]. Available: https://www.microsoft.com/en-gb/microsoft-teams/group-chat-software

[37] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology*, vol. 3, pp. 77–101, 2006.

[38] "Nvivo." [Online]. Available: https://lumivero.com/products/nvivo/

[39] "Tiktok." [Online]. Available: https://www.tiktok.com/en/

[40] E. Tropman, "In defense of reading quizzes," *International Journal of Teaching and Learning in Higher Education*, vol. 26, pp. 140–146, 2014. [Online]. Available: http://www.isetl.org/ijtlhe/

[41] L. Rello and R. Baeza-Yates, "The effect of font type on screen readability by people with dyslexia," *ACM Trans. Access. Comput.*, vol. 8, no. 4, may 2016. [Online]. Available: https://doi.org/10.1145/2897736

[42] Mar 2024. [Online]. Available: https://en.wikipedia.org/wiki/Usage_share_of_web_browsers

[43] "Figma." [Online]. Available: https://www.figma.com/

[44] C. S. V. Meel, J. Oosterlaan, D. J. Heslenfeld, and J. A. Sergeant, "Telling good from bad news: Adhd differentially affects processing of positive and negative feedback during guessing," *Neuropsychologia*, vol. 43, pp. 1946–1954, 2005.

[45] [Online]. Available: https://obsproject.com/

[46] B. Hanington, *Universal Methods of Design : 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions*. Osceola. Ebook Central: Quarto Publishing Group USA, 2012.

[47] [Online]. Available: https://developer.chrome.com/docs/extensions/get-started

[48] "Gpt turbo models." [Online]. Available: https://platform.openai.com/docs/models/gpt-3-5-turbo

[49] [Online]. Available: https://support.google.com/chrome/answer/13156494?hl=en-GBzippy=%2Cuse-side-panel

[50] [Online]. Available: https://platform.openai.com/playground

[51] L. Rello and J. P. Bigham, "Good background colors for readers: A study of people with and without dyslexia." Association for Computing Machinery, Inc, 10 2017, pp. 72–80.

[52] A. Bangor, P. Kortum, and J. Miller, "Determining what individual sus scores mean: Adding an adjective rating scale," *Journal of usability studies*, vol. 4, no. 3, pp. 114–123, 2009.

[53] [Online]. Available: https://forms.office.com/

[54] J. Brooke, "Sus: a retrospective," *Journal of usability studies*, vol. 8, no. 2, pp. 29–40, 2013.

[55] A. Dix, *Human-computer interaction*. Pearson Education, 2003.

Appendix A

ADHD Private Screening Prices

Table A.1: First 9 Google Results for Private ADHD Screening

Expert No.	**Expertise**
£360	https://psychiatry-uk.com/fees/
£530	https://www.adhd-360.com/pricing/
£600	https://adhd-clinics.co.uk/fee-adult-600-child-700/
£1750	https://edinburghpractice.com/new-clients/our-fees/
£895	https://www.clinical-partners.co.uk/fees
£1600	https://adhdclinic.co.uk/prices/
£1150	https://www.adhdcare.co.uk/?p=fees
£825	https://www.berkeleypsychiatrists.co.uk/fees
£1050	https://edinburghadultpsychiatry.co.uk/fees/
£973.33	**Average Price**

The prices listed assume a negative diagnosis and reflect the most basic assessment packages. A positive diagnosis would significantly increase costs due to additional mandatory expenses, including a second consultation, medication, and monthly titration, among others.

Appendix B

Participants' information sheet

Participant Information Sheet

Project title:	E-learning Accessibility in Higher Education
Principal investigator:	Dr Aurora Constantin
Researcher collecting data:	Jack McDermott
Funder (if applicable):	N/A

This study was certified according to the Informatics Research Ethics Process, reference number 809800. Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

Jack McDermott – undergraduate student collecting and analysing data;

Wei Zou – undergraduate student having access to data;

Aurora Constantin – principal investigator, research supervisor;

What is the purpose of the study?

The purpose of the study is to assess current state of e-learning accessibility in higher education based on three target groups: students with attention disorders and students with mobility impairments. Based on the gathered data, prototypes of possible solutions will be developed and assessed.

Why have I been asked to take part?

You have been asked to take part in the research as you identify as a person with an attention disorder and/or are an expert in the digital accessibility area.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, up until the completion if your interview without giving a reason. After this point, personal data will be deleted and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If you wish to withdraw, contact the PI. We will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

If you decide to take part you will be invited initially to take part in at least one semi-structured interview. You may be invited to further user studies also. The initial interview will be guided by a set of questions and adapted as required to your responses. Interviews will take between 15 minutes and 1 hour to conduct, depending on the detail of your answers.

Interviews will be conducted either in-person or online via Teams. Every online interview will be video and audio-recorded via Teams' embedded recording tool, every in-person interview will be recorded via note taking on a laptop and audio-recorded via a mobile phone. All the audio data will be transcribed, and the video and audio data will be deleted after transcription to facilitate data anonymisation and analysis. All the questions will be related to your experience at University as a student with an attention disorder such as ADHD or ADD.

Are there any risks associated with taking part?

There are no significant risks associated with participation.

Are there any benefits associated with taking part?

There are no material or financial benefits associated with taking part in the study.

What will happen to the results of this study?

The results of this study may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized: We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research. Your data may be archived for a maximum of 4 years. All potentially identifiable data will be deleted within this timeframe if it has not already been deleted as part of anonymization.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the researcher/research team consisting of Dr Aurora Constantin, Wei Zou, Jack McDermott.

All electronic data will be stored on a password-protected encrypted computer, on the School of Informatics' secure file servers, or on the University's secure encrypted cloud storage services (DataShare, ownCloud, or Sharepoint) and all paper records will be stored in a locked filing cabinet in the PI's office. Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

The University of Edinburgh is a Data Controller for the information you provide. You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the lead researcher, Dr Aurora Constantin, +44 131 651 5643, aurora.constantin@ed.ac.uk

If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be made available on http://web.inf.ed.ac.uk/infweb/research/study-updates.

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact Jack McDermott at jackpanos@gmail.com.

General information.

For general information about how we use your data, go to: edin.ac/privacy-research

Appendix C

Participants' consent form

Participant number:_____

Participant Consent Form

Project title:	E-Learning Accessibility in Higher Education
Principal investigator (PI):	Aurora Constatin
Researcher:	Jack McDermott
PI contact details:	aurora.constantin@ed.ac.uk

By participating in the study you agree that:

- I have read and understood the Participant Information Sheet for the above study, that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.
- My participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.
- I consent to my anonymised data being used in academic publications and presentations.
- I understand that my anonymised data will be stored for the duration outlined in the Participant Information Sheet.

Please tick yes or no for each of these statements.

1.	I agree to being audio recorded.	☐ **Yes**	☐ **No**
2.	I agree to being video recorded.	☐ **Yes**	☐ **No**
3.	I allow my data to be used in future ethically approved research.	☐ **Yes**	☐ **No**
4.	I agree to take part in this study.	☐ **Yes**	☐ **No**

Name of person giving consent	Date dd/mm/yy	Signature
_____	_____	_____
Name of person taking consent	Date dd/mm/yy	Signature
_____	_____	_____

THE UNIVERSITY of EDINBURGH informatics

Appendix D

Summative Evaluation Graphs

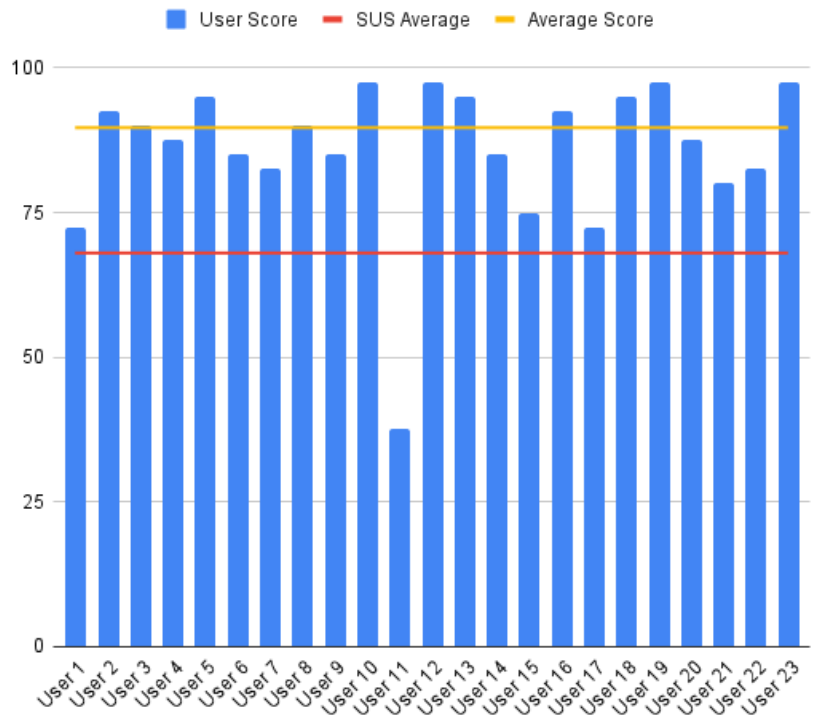


Figure D.1: SUS Questionnaire Scores From Each Participant on Project Day

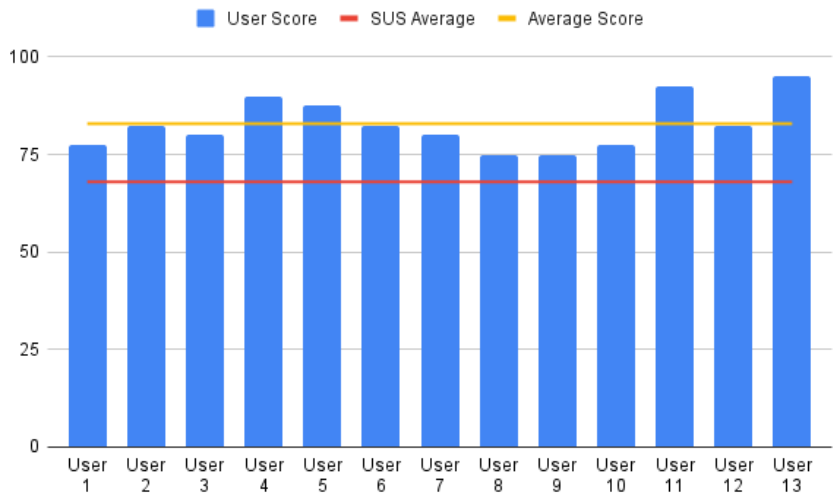


Figure D.2: SUS Questionnaire Scores From Each Participant during Summative Evaluation

Appendix E

SUS Questionnaire

ADHD Reading Assistant Questionnaire

This study aims to evaluate the functionality, design, and usability of a prototype for a Google Chrome Extension created to help those with ADHD do reading online. During this study, I will ask you to view and potentially use the prototype. I will then ask you to complete a quick questionnaire on your experience with the application. If you feel uncomfortable about your participation in the study at any time, you are free to leave. There will not be any compensation for participation in this study. This study will be used to evaluate and improve upon the designed User Interface and the functionality for the Chrome Extension, any feedback you provide will be used for this purpose along with anonymous use in related work. The responses will be kept for the duration of the project, then destroyed. Anonymized quotes, and data may be retained longer for use by future students on this project.

The project is supervised by Dr Aurora Constantin (aurora.constantin@ed.ac.uk) and conducted by myself, Jack McDermott (s2085719@ed.ac.uk).

Please Note : By filling this form you agree to have read the Participant Information Sheet which is attached to this form. If you have any questions please send them to s2085719@ed.ac.uk.

https://uoe-my.sharepoint.com/:b:/g/personal/s2085719_ed_ac_uk/Ea3H6_IZB2pKsONoBKCAq5QBVLddNK-aHtgUkhRcG5VO4A?e=sLO3Sq ***PARTICIPANT INFORMATION SHEET***

1. Please answer each question honestly and read each statement *extra* carefully

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I think that I would like to use this system frequently.	◯	◯	◯	◯	◯
I found the system unnecessarily complex.	◯	◯	◯	◯	◯
I thought the system was easy to use	◯	◯	◯	◯	◯
I think that I would need the support of a technical person to be able to use this system	◯	◯	◯	◯	◯
I found the various functions in this system were well integrated.	◯	◯	◯	◯	◯
I thought there was too much inconsistency in this system.	◯	◯	◯	◯	◯
I would imagine that most people would learn to use this system very quickly.	◯	◯	◯	◯	◯
I found the system very cumbersome to use.	◯	◯	◯	◯	◯
I felt very confident using the system.	◯	◯	◯	◯	◯
I needed to learn a lot of things before I could get going with this system.	◯	◯	◯	◯	◯

2. What did you like MOST about the extension?

3. What did you like LEAST about the extension?

4. What suggestions do you have to improve the extension?

5. Are there any visual/design choices you didn't like?

6. Anything to add? (if you feel you want to explain an answer from the multiple choice, or considerations you believe I should make as the development progresses)