InsightSpace:

Broadening Inclusive Education Horizons for Vision Impairment

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A Master's Thesis
Submitted to Department of Human-Centered Design
Faculty of Industrial Design Engineering
Delft University of Technology
In fulfillment of the Requirements for
M.Sc. Design for Interaction - Medisign Specialization

November 2023

Preface

*This report is a component of the Master **Design for Interaction** program, **Medisign** specialization. Alongside a video that demonstrates the final concept, it outlines the process and results of a final project undertaken in **Human-Centered Design** department of **Industrial Design Engineering** faculty, in collaboration with the Ethics/Philosophy of Technology section of **Values, Technology and Innovation** department of **Technology Policy and Management** faculty for the client **Envision Technologies B.V**.*

Reflecting the project's theme and spirit, this report primarily relies on text with limited visual elements, in an attempt to set an example of how to create accessible documents for those with vision impairments. For the same purpose, it incorporates atypical formats for a thesis, such as alt text, non-justified text paragraphs, and generally larger text fonts and line spacing for easier readability.

Abstract

*This thesis explores the challenges faced by **students with vision impairment** in accessing visual educational content, with the goal of designing an inclusive tool to enhance their learning experience. Adopting a human-centered design approach backed with value-sensitive design, the research methodology combined qualitative and quantitative techniques including interviews, surveys, and design ethnography. These methods provided insights into the lived experiences of visually impaired students, revealing difficulties in comprehending complex visual data and feelings of exclusion from the academic community.*

*The design process was structured around four key phases – **Exploration, Ideation**, **Iteration**, and **Implementation**. The Exploration phase involved in-depth user research to identify needs and values. Ideation generated numerous concepts, with a focus on converting visual content into accessible multisensory formats. Iteration prototyped and tested these concepts to refine the designs based on user feedback. Finally, Implementation delivered the high-fidelity prototype – an AI-powered platform called "**InsightSpace**" that integrates with the Brightspace LMS.*

*Key features of InsightSpace include the "**InsightOut**" tool which leverages AI to interpret and narrate visualizations, and the **Envision Ally** community portal that facilitates collaborative learning. The concept aligns with design values like accessibility, inclusiveness, personalization, and community identified through the research. Evaluation metrics focus on usability, user satisfaction, and platform effectiveness in conveying visual information.*

The thesis concludes that InsightSpace demonstrates the potential of inclusive design and assistive technology in transforming educational experiences. It underscores the importance of multifaceted research and continuous user involvement in developing empathetic solutions.

The platform marks progress in the mission to create learning environments where students with vision impairment can thrive alongside their sighted peers.

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Acknowledgements

This thesis represents a journey of learning and growth, made possible by the support and guidance of many.

My heartfelt thanks go to my supervisors; Stella, who stood by me through ups and downs; Annemiek, who was my beacon during dark days; and Lavinia and Ferkan for their invaluable guidance and insightful feedback throughout this project.

My brief collaboration with the team at Envision has been enriching. I appreciate the opportunity to contribute to such a meaningful project.

I am grateful to all the participants , students, and lecturers, who shared their experiences and insights, significantly enriching this research.
A special thanks to Amir Deljouyi for his technical expertise in fixing my codes!

Lastly, I extend my deepest love and gratitude to my dearest Mohammadreza and my wonderful family for their unwavering belief in me.

Thank you all for being an integral part of this journey.

Dedication

Dedicated to the valiant young souls in Iran, who faced the wrath of bullets for their quest for ***Woman, Life, Freedom****.*

Their eyes were targeted, *a cold attempt by the regime* ***to cloud their vision, yet their hearts saw clearer than ever before.***

Their courage paints the streets with shades of resistance, imprinting a path of defiance for generations to tread upon. They stand as monumental symbol of hope amidst the dark days. Their narrative, a reminder of the resilience, breathing within the spirit of the oppressed, echoes through my endeavor to design for the sightless, igniting a spark of ***rebellion against the darkness*** *imposed.*

May each page of this work be a tribute to their unyielding spirit, a step towards the ***dawn of justice*** *they fought for.*

Introduction

In today's classrooms, not everyone has the same starting line, especially students who see the world differently—with vision impairments. When I started studying Design for Interaction at Delft University, one question stood out: How can we help everyone belong? Sure, making everything perfect for everyone is a tall order. However, this does not mean that we should not try it.

This project aims to provide these students with the tools they need to engage fully in the visual world, inviting them into the academic community as equal participants, and helping them feel like a part of our academic community, rather than guests who need special invites.

*As we move forward in **IDE-TU Delft** with a spirit of "**Design for the Future**," let's explore the experiences, needs, values, aspirations, and untapped potential of students with vision impairment. How can we shape educational content into something that is. accessible, inclusive, and inviting to everyone? Welcome on this journey.*

Introduction

Welcome to the exploration of a critical challenge in education today: the need for inclusivity in visual educational content for students with vision impairment. With advancements in technology and pedagogy, you'd think we'd have this figure out. But the reality? We're far from it. This research aims to unravel this complex web and make strides toward more inclusive educational settings.

Context and Background

The digital era has enveloped the education sector, bringing a surge in visual educational content. This shift, while beneficial for many, unveils a unique set of challenges for students with vision impairment. The growing reliance on visual material often leaves students grappling with inaccessible content, leading to alienated experiences. This issue does not just stop at accessibility; it also unveils the broader narrative surrounding inclusive design and the role that educational institutions play in nurturing it.

The narrative of inclusive education is not new; yet, the realm of higher education often finds itself scrambling when catering to the needs of visually impaired students. Despite these advancements, the reality remains that we are far from achieving a truly inclusive educational setting. The challenges faced by these students are not just about accessing content; they are about creating an environment that does not alienate or sideline them.

Furthermore, the stakeholders in the educational domain–educators and administrators–carry the mantle of providing the necessary support and accommodations to facilitate an inclusive learning environment. The onus is not just on infrastructural adjustments, but extends to the pedagogical approaches adopted to ensure that learning is not a herculean task for students with vision impairments.

Inclusive Education for Vision Impairment

Inclusive design is an approach to improve accessibility for people with disabilities (Walsh & Wronsky, 2019). This research project focuses on inclusive education for students with vision impairment at the higher education level, involving **various key stakeholders**. **Students with**

vision impairment were at the heart of this study, considering their unique experiences and the challenges they face in the context of education (Figure 1-1). Additionally, **educators and administrators** at higher education institutions assume a pivotal role, entrusted with the responsibility of providing the necessary support and accommodations to facilitate an inclusive learning environment. A key aspect that can mediate the relationship between independent and dependent variables, such as problem-solving ability and academic performance, is important for design thinking. Recognizing the need for innovative solutions, the integration of Envision glasses and artificial intelligence (AI) technology shows a potential path for addressing the challenges faced by students with vision impairment at the higher education level.

To establish this thesis's foundation, an in-depth review of literature on inclusive education for visually impaired students is essential. This review will identify gaps, explore innovative strategies, and build a comprehensive understanding of the subject. The following sections discuss the theoretical framework, methodologies, and expected outcomes of this study.

Figure 1-1. The scope of problems that will be the focus of this project is marked in purple, considering the context of application and objectives of collaboration with Envision.

About Envision

Envision, a startup that emerged from the Yes!Delft incubation at Delft University of Technology, uses artificial intelligence to improve interaction and communication for individuals with visual impairment. The company's core mission is to **empower people with visual impairment**, enabling them to become **more independent**. They follow a **human-centric design** philosophy, collaborating closely with users to create solutions that are relevant and effective.Envision offers several products designed to address the specific needs of individuals with visual impairment.

- **Envision App**: available on both iOS and Android platforms, provides a range of functionalities aimed at enhancing accessibility.
- **Envision Glasses**: Adapted on Google Glasses, the Envision Glasses leverage speech recognition technology, allowing users to navigate and interact with their surroundings more effectively.
- **Envision Ally**: a video calling feature that facilitates connections between visually impaired individuals and others who can act as their eyes, providing assistance and guidance when needed.

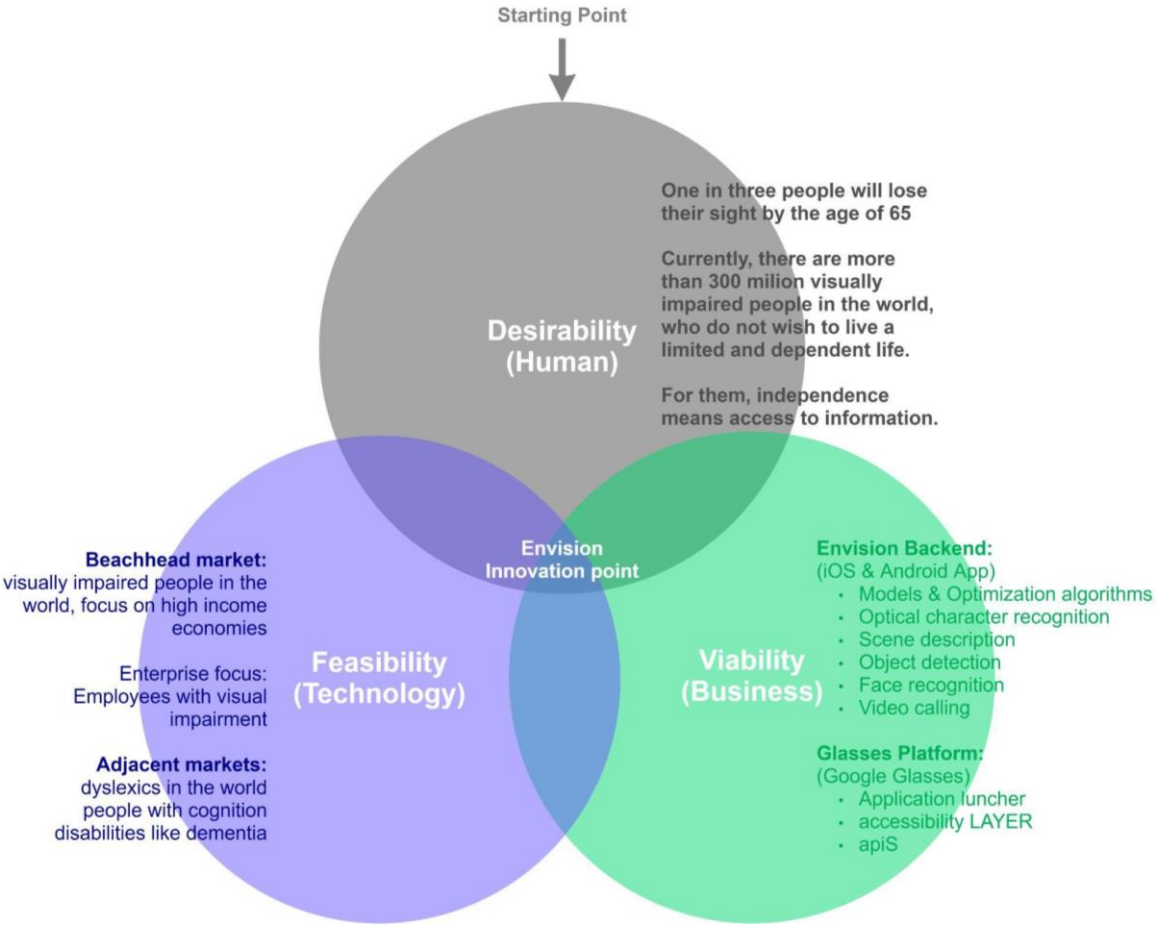


Figure 2Figure 1 2. Context: Human, Technology, and Business side of the innovation by Envision.

The increasing importance of inclusive higher education for visually impaired students has been widely acknowledged in recent years. To address this crucial issue, assistive technologies, such as Envision AI, have emerged as potential solutions, offering remarkable capabilities in object recognition and text reading. By utilizing a camera integrated into Envision Glasses, visually impaired students can effortlessly access a diverse range of educational materials and resources. This not only promotes their independence, but also enables their active engagement in the educational process.

One of the objectives of this project was to **explore the potential of Envision products to enhance the accessibility of higher education for visually impaired students**. Additionally, it seeks to **design a system that seamlessly integrates the existing educational infrastructure** to ensure practical implementation. The incorporation of Envision products into the higher education setting presents numerous benefits to students with vision impairment. For example, glasses can provide audio descriptions of printed materials, including textbooks and class notes, significantly improving students' ability to participate in class discussions and complete assignments. Moreover, they can offer real-time audio descriptions of visual aids and instructional materials used by educators during lectures, empowering students with vision impairment to fully engage with the subject matter.

Nevertheless, it is crucial to acknowledge and address potential challenges associated with fostering inclusivity in higher education. This project will extensively examine **how visually impaired students can be effectively supported within the higher education context**, including a thorough evaluation of the **suitability of Envision service**s and the exploration of **alternative design solutions**. It is worth noting that not all visually impaired students may find the glasses suitable, as some may require specialized training and support to effectively utilize the technology. Moreover, cost considerations may cause financial barriers for certain students, particularly for those without access to sufficient financial aid or other forms of assistance.

In conclusion, the adoption of the Envision App and Glasses holds significant potential for enhancing the educational experience of visually impaired students and promoting a more inclusive and accessible higher education system.

Problem Statement

Transitioning to higher education (HE) poses significant challenges for many students (Cameron & Thygesen, 2015). These obstacles encompass various aspects, including **social**, **personal**, **content-related**, and **organizational** factors (Perry et al., 1997). Among students with visual impairments, **independent reading,** and **navigation** to lectures and workgroups can be particularly difficult (Hewett, 2018).

Despite the existence of the UN Convention on the Rights of Persons with Disabilities, digital accessibility in universities remains a persistent issue (Dangoisse et al., 2019). Students with vision impairments often encounter additional hurdles in higher education, such as lower college attendance and graduation rates, compared to their peers without visual impairments. This suggests a lack of adequate support services and accommodations in universities. Challenges may include difficulties in accessing course materials, taking notes during classes, and navigating the campus despite the availability of accommodations such as screen readers, braille displays, electronic magnifiers, note-taking assistance, and orientation and mobility training for campus navigation.

Envision products offer potential value beyond existing tools available to visually impaired students. This technology allows hands-free access to information, real-time access to class schedules, campus maps, and other useful resources for visually impaired students. Envision products or similar technologies can also provide assistive features such as text-to-speech and speech-to-text software. However, there is currently a knowledge gap regarding whether Envision technology aligns with the needs of higher education students and how its functionalities can support their studies. Addressing this gap is in line with the challenge presented in the introduction and offers a feasible problem to tackle within the scope of this research.

Thus, this research aims to **investigate the situation of inclusion or exclusion of students and the reasons behind it, as well as the experiences, desires, and needs of visually impaired students in higher education**. It seeks to understand the context and determine how these needs can be effectively supported through design. To achieve this goal, it is essential to identify **measurable values of inclusivity** that encompass **accessibility** as part of the approach outlined in the subsequent chapter.

Research Objectives and Questions

This study aimed to understand the unique challenges and needs of students with vision impairments in accessing visual educational content, along with designing a tool that translates visual educational materials into an accessible format for these students.

At the forefront of this exploration is the need to delve into the lived experiences of visually impaired students and understand their unique challenges within the higher education landscape. The objective was to examine existing assistive technologies and identify the gaps that hinder a truly inclusive educational experience.

Moreover, the project aims to explore the potential of Envision products to enhance the accessibility of higher education for visually impaired students. The goal is to design a system that seamlessly integrates the existing educational infrastructure to ensure practical implementation. Understanding how Envision products, especially Envision Glasses, can be tailored to meet the educational needs of visually impaired students is a pivotal part of this research.

The initial objective (design goal) is as follows:

“Designing a tool that improves the sense of inclusivity for students with vision impairment.”

The lateral objectives are as follows:

- Understanding the unique challenges and needs of students with vision impairments feeling **included** in higher education and in **accessing** visual educational content.
- Understanding the unique challenges and needs of students with vision impairments in **accessing visual educational content** and questioning how to create a non-visualized version of visual content?
- Designing a tool to enable access to visual educational content for students with vision impairment.

Justification and Rationale

This study aims to enhance inclusivity in educational settings where accessible design, especially for visually impaired students, is often overlooked. With the increasing use of visual elements in education, there's a pressing need for innovative, inclusive solutions. Leveraging Envision glasses and AI technology, this research addresses these challenges in higher education, focusing on creating a learning environment that embodies true inclusivity. A thorough review of current literature and research on inclusive education forms the basis of this thesis, identifying gaps and exploring new strategies for a deeper understanding of the subject within the wider context of inclusive design in education.

Methodological Approach

This research employs a mixed-method approach, combining qualitative and quantitative methods like empathic user interviews and prototype testing. Each method is carefully chosen to deeply understand user needs and iteratively refine the design.

The design process starts by planning, defining the project's scope, and employing various research methods to explore the subject area. The gathered information will form the basis of the project plan, guiding it towards impactful design implications.

In the immersive exploration phase, design ethnography and synthesis are key. Techniques like observations, interviews, and experience sampling are used for developing an empathic understanding of users. Mind mapping and journey mapping help in synthesizing insights, highlighting critical experience touchpoints, and leading to informed design implications.

Structure of the Thesis

- Chapter 1: Literature Review
- Chapter 2: Methodology
- Chapter 3: Design Process
    - 3.1 Exploration
    - 3.2 Ideation
    - 3.3 Iteration

      3.4 Implementation
- Chapter 4: Conclusion

Scope and Limitations

This study specifically orbits university-level education with a vision to propose a viable solution. The acknowledgment that perfection is elusive is crucial, but the intention is to contribute to broader inclusivity, with the immediate goal being tethered to visual educational content.

The adoption of the Envision App and Glasses holds a beacon of hope for enhancing the educational experience of visually impaired students and marching towards a more inclusive and accessible higher education system. However, it is crucial to acknowledge the potential challenges that may arise from the suitability of envision services to financial barriers that might pose hurdles for certain students.

Moreover, the focus narrows down to students between the ages of 18 and 25 who are currently enrolled in higher education institutions. While the project is inclusive in its essence, owing to the sensitivity of obtaining consent and implementing ethical measures, participants under the age of 18 are beyond the scope of this project. The scope and limitations of this study are not just about demographic boundaries, but extend to the practical and financial realms, each dissected and explored in depth.

Conclusion of the Introduction

Navigating through this thesis, a deeper insight into each aspect of the problem will be sought by understanding the unique challenges that students with vision impairments face in designing a tool that aims to simplify their educational journey. While every issue may not be resolved, this research aspires to nudge toward broader educational inclusivity.

Chapter 1: Literature Review

Navigating the landscape of inclusive education for students with vision impairment is intricate and multifaceted. This literature review delves into several critical areas: inclusive design, the role of Design Thinking and Value-Sensitive Design, the potential of Product-Service Systems (PSS), and the capabilities and limitations of assistive technologies. It becomes evident that While strides have been made in inclusive design principles and technological advancements, there is a significant gap in applying these comprehensively and effectively in educational settings for students with vision impairment. Specifically, current solutions often lack a harmonious integration of ethical considerations, nuanced individual needs, and effective use of technology. This review establishes the groundwork for addressing these gaps by formulating research questions aimed at designing inclusive educational tools.

Overview

Inclusive education remains a significant challenge for students with vision impairment, and it warrants a multipronged approach. This comprehensive literature review explores several facets, including design thinking, assistive technologies, and barriers to inclusion, to illuminate design gaps in current educational settings. This investigation aimed to formulate research questions directed at designing tools to enhance inclusivity for students with vision impairment.

Context of Inclusive Education

Inclusive Design

Inclusive design is about making things accessible and usable for everyone, regardless of their age, ability, or background. It can be applied in many areas such as education, architecture, and product design. The main idea is to consider the diverse needs and abilities of all users from the start of the design process to promote social inclusion and equality (Cardoso et al., 2002).

Ozdemir & Sungur Ergenoglu (2018) examined inclusive design in education and stressed the importance of creating inclusive educational environments that cater to everyone is needs. Their study showed that inclusive design could help build better social relationships and contribute to urban development by designing public spaces and educational settings that are accessible to all.

On the other hand, Bichard (2020), in the book of "Are you an inclusive designer?", dives into the key issues of inclusive design, including its history, legal aspects, technical advancements, and real-world examples. The book underscores the importance of considering diverse user needs from the get-go perspective, focusing on creating accessible and inclusive environments.

Inclusive design is not only related to physical spaces. This also extends to products and services. An increasing number of designers are realizing the importance of inclusive design in making products usable by a wide range of individuals. This includes creating user-friendly interfaces, using adaptive technologies, and considering ergonomic factors to cater to the diverse needs and abilities of the users.

The inclusive design approach challenges traditional design practices, which often assume specific physical and mental capabilities, aesthetic ideals, and interests. It aims to ensure that

products, structures, and services are accessible and usable by the greatest number of people regardless of their abilities or characteristics (Steinfeld & Maisel, 2012). This shift in focus from individual capabilities to social context emphasizes the importance of involving actual users in the design process.

Designers can create inclusive solutions by analyzing demographic data and considering the percentage of individuals who may face barriers in using a product or accessing a service. The integration of simulators and user interaction helps challenge misconceptions about disabilities and encourages designers to leverage the lived experiences and knowledge of diverse participants.

Walker & Giard (2013) developed the Generic Design approach to simplify inclusive design models and bring together multiple design processes from various disciplines, such as engineering, ergonomics, and usability. This approach shares similarities with interaction design in human–computer interaction (HCI), as both aim to create products that are usable by a wide range of people.

Inclusive design plays a critical role in creating accessible and usable products, structures, and services for a diverse range of individuals. By embracing inclusive design principles, designers can contribute to a more mobility-aware society and break down the barriers that exclude certain segments of the population.

Inclusive Education

Inclusive education, while not a new phenomenon, presents unique challenges for students with vision impairments. The framework suggested by Hewett et al. (2020) strikes a balance between inclusive design and individual adjustments to meet specific needs. This framework argues for a multifaceted approach that combines broad inclusive practices with tailored solutions. Similarly, difficulties were identified in accessing e-print and large-format materials for these students (Opie et al., 2017). These studies underscore the importance of a nuanced approach to inclusive education for visually impaired students.

Inclusive Design in Education

The concept of Inclusive Design offers an actionable pathway for addressing these challenges. Originating from architecture, Inclusive Design in the context of education focuses on creating learning environments and tools that are accessible to as many people as possible (Cardoso et al., 2002). The goal is not merely to provide alternative access, but to enrich the educational experience for all (Leporini & Paternò, 2008).

Barriers to Inclusion: A Multi-dimensional Problem

Challenges to inclusive education extend beyond physical barriers; they are both attitudinal and systemic. Shortages of human and material resources, teaching methods, and attitudes that contribute to the poor academic performance in science subjects are highlighted in studies (Habulezi et al., 2017; Kisanga, 2022). Therefore, a comprehensive strategy is required to address these issues.

International Perspectives: A Global Concern

Globally, inclusive education varies considerably. In Lebanon, a study indicated a lack of autonomous decision-making for students with vision impairment and their parents, pointing to the unpreparedness of mainstream schools for inclusion (Khochen, 2017)**.**

Role of Design Thinking and Value-Sensitive Design

Design Thinking

Design Thinking, with its roots in solving complex problems, can potentially serve as a tool for addressing inclusivity issues in educational settings, particularly for students with vision impairment. As noted, Design Thinking is being recognized not merely as a creativity tool but a set of expertise and tools that need to be applied contextually. Scholars such as Nussbaum and Collopy have underlined the need for a more precise theoretical underpinning of the concept of Design Thinking, hinting at a possible area of exploration in the context of designing for inclusivity (Nussbaum, 2013; Boland & Collopy, 2010).

Narrative encircling Design Thinking has witnessed a paradigm shift, as underscored by Dean Roger Martin, emphasizing a multidisciplinary academic trajectory, which could potentially encompass the domain of inclusive educational design (Martin, 2011). Eminent contributors, such as Simon, Schön, and Buchanan, among others, have enriched the discourse around Design Thinking, each from a unique vantage point, shedding light on the diverse intellectual landscapes it traverses (Buchanan, 1992; Schön, 2017; Simon, 1969).

Furthermore, instances of applying Design Thinking across various domains, as exemplified by winemakers and design students (Cross, 1982; Lawson, 2006), underscore its versatility, hinting at its potential applicability in crafting inclusive educational experiences. However, the call for more profound theoretical exploration to amalgamate the disparate methods and approaches within Design Thinking resounds, marking a potential trajectory for this master's thesis to contribute towards a refined understanding of Design Thinking in management realms and beyond.

Value-Sensitive Design

On the other hand, Value-Sensitive Design (VSD) incorporates ethical and social considerations into the design process (Friedman et al., 2013). In the context of education for students with vision impairment, it is imperative to address not only functional but also social and ethical values, such as dignity, independence, and equality (Cummings, 2006).

Value-sensitive design (VSD) has emerged as a potential methodology that incorporates human values into the design process. The need to apply these methodologies in educational settings is yet to be explored.

Synergy and Gaps

When combined, Inclusive Design and VSD provide a robust framework for creating an inclusive educational environment. Inclusive Design's principles directly respond to the question of "How can visually impaired students feel more included at university?" by encouraging multifaceted accessibility (Shinohara & Wobbrock, 2011). Simultaneously, VSD adds depth by urging designers to consider the ethical implications of their choices, thereby tackling the question, "How to create a non-visualized version of visual content?" (Erlandson, 2007).

While these design philosophies offer much promise, a noticeable gap persists in their application to the specific context of higher education for students with vision impairment. Most existing literature and design practices target generalized accessibility issues without fully considering the unique requirements of these students. Furthermore, there is a lack of practical design solutions that successfully integrate both Inclusive and Value-Sensitive Design principles, which could be pivotal for genuinely inclusive educational tools.

Product Service Systems (PSS)

Product-Service Systems (PSS) combine products and services. This idea came up in Northern Europe in the late 1990s to help companies stand out from competitors, care more about the environment, and not just focus on selling cheap products (Tukker, 2004). In recent years, there has been a lot of discussion about PSS, but most of it remains in theory. More real-world studies are needed to better understand this phenomenon (Mont, 2002).

PSS can be useful in education, particularly for students with vision impairment. It suggests moving from traditional ways, where the focus is mainly on products, to a new way that combines products and services. This can make education more inclusive and better suited to the needs of visually impaired students. For instance, by adopting PSS, schools and universities can offer tailored support, such as help with navigating around, accessing visual content, and personal tutoring sessions (Baines et al., 2009).

The idea of servitization is closely related to PSS. It talks about shifting from offering products to services. In the world of education, this could mean developing new support services, technological tools, and personal help that cater to the specific needs of visually impaired students. This shift can help make the educational experience more inclusive and provide equal opportunities for all students (Neely, 2008).

However, introducing PSS into education is not a challenge. Things such as cultural differences and the varied needs of visually impaired students need to be considered when making PSS projects work well. Understanding these challenges and tailoring the design of PSS solutions can help to create a more inclusive environment for visually impaired students (Baines et al., 2009).

The rise of digital technologies such as artificial intelligence, assistive devices, and inclusive digital platforms can further help in applying PSS in education. These technologies can improve

accessibility and help visually impaired students fully participate in educational activities (Meier et al., 2010).

In conclusion, PSS offers a fresh framework for designing inclusive educational experiences for visually impaired students. It is possible to make education more accessible and inclusive by blending services with the educational infrastructure and leveraging digital technology. Through a thorough understanding of PSS concepts and exploring their application in higher education, this design project aims to contribute to advancing inclusive education for visually impaired students.

Assistive Technologies: Opportunities and Limitations

The significance of technology in even-out educational opportunities is well-recognized. However, there is a gap between the technology's potential and its effective application for students with vision impairment (Opie, 2018). Practical issues, such as ineffective technology for board-work and worksheets and the teaching of programming to these students, point to this gap (Alotaibi et al., 2020).

AI-driven Solutions: Envision.ai and Envision Glasses

While not tailored to educational settings, AI-driven platforms such as Envision.ai and Envision Glasses serve people with vision impairment in daily life activities. These platforms can potentially be adapted for educational purposes, thereby opening new avenues for research and development.

Impact of the Covid-19 Pandemic

The shift to online education owing to the Covid-19 pandemic has heightened the need for inclusivity. Zdravkova & Krasniqi (2021) emphasized that the pandemic has exacerbated existing inequalities in educational settings. This new normal makes the requirement for inclusive educational tools even more urgent.

Conclusion and Design Gaps

This section explains how design can help in inclusive education. It looks at different aspects of inclusiveness, like physical and social ones, and different design ways, like combining products and services. The review shows that design can be approached in many ways, and it's important to have a clear goal. So, the design goal has been updated to:

"Designing a tool that improves the sense of inclusivity and broadens access to visual educational content for students with vision impairment."

The following are the research questions in response to this goal:

- How can students with vision impairment feel more included at the university?
- How to create a non-visualized version of visual content?

The next chapter will talk more about the research methods and design steps needed for this project.

Chapter 2: Methodology

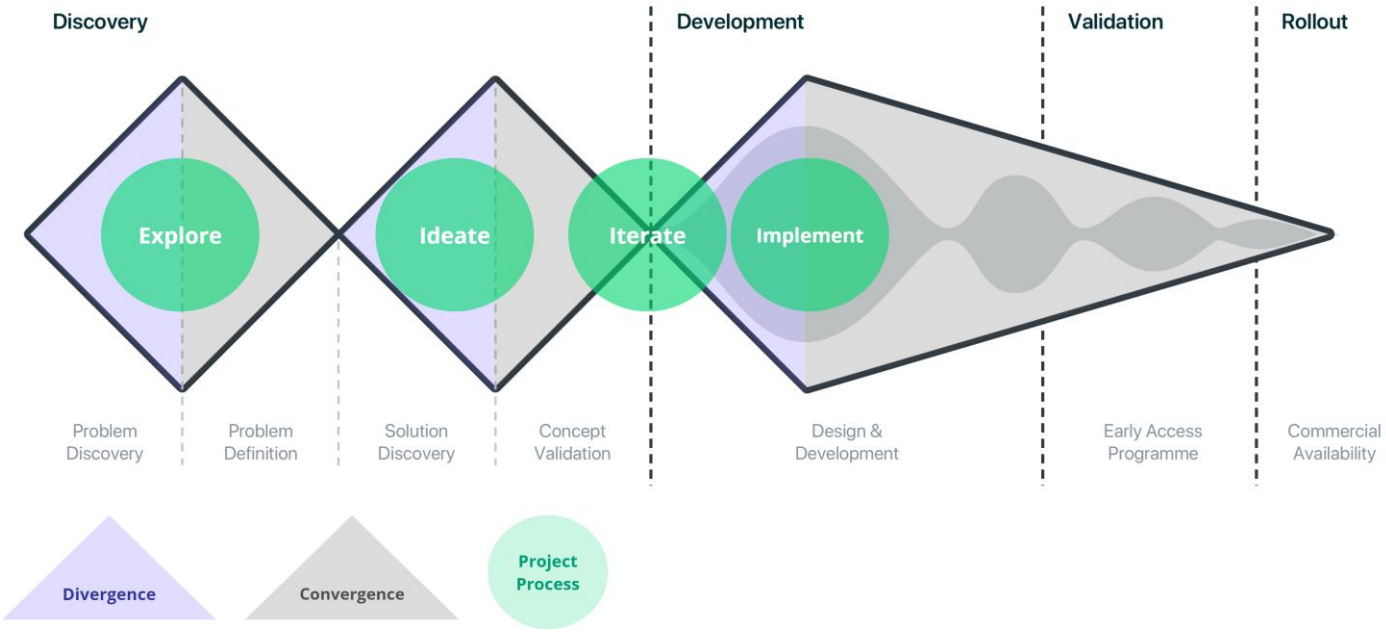
This chapter outlines the research methodology used to address the challenges of inclusive education for students with vision impairment. It covers research design, methods, sampling, data collection and analysis, and ethical considerations. The goal was to provide a comprehensive understanding of the approach used to ensure valid and reliable findings that guide the design process.

Introduction

This chapter serves as a guide for the research methodology employed in this study. It explains the research design, methods, sampling strategy, data collection, analysis techniques, and ethical considerations. These elements collectively aim to answer research questions focused on fostering inclusive education for students with vision impairment.

Project Process

As explained in the Delft Design Guide, before a project starts *staging* is needed (van Boeijen et al., Eds. 2020) that is the design of the process itself (the perspective on design (here, design for inclusion), methods, tools, and intermediate results). This project follows a human-centered approach to deeply understand the needs and preferences of the target audience. Typically for a design project a mix of methods and tools are used. The process distinguishes moments of *diverging* in which the scope is broad and moments of *converging* in which the scope is narrowed down, findings are synthesized into concrete intermediate solutions. A simplified model in which this diverging and converging approach is emphasized is the Double Diamond with four distinctive phases: Discover (exploration), Define (goal setting), Develop (ideation), and Deliver (in this project evaluation and reporting) (Design Council, 2005). The model represents as a linear process, however, in reality a design process is highly iterative, going back and forth, rethinking steps and insights from an earlier moment in time.



The project was divided into two phases: planning and design. Planning, where the focus is on understanding the project scope and research questions, is executed through literature and field research.

The design process is then divided into four phases: **Exploration, Ideation, Iteration, Implementation**. This is a deep dive into user research to gather insights that will shape the design. This was followed by brainstorming sessions to develop initial design ideas and build early prototypes. Finally, the project concludes by testing and refining the design and preparing it for a market launch. Future updates and reviews will be part of this plan.

Discover – Exploration & Define – Goal Setting

The project started by setting the initial goal and identification of who is involved. This was followed by a flexible process of research and idea testing to clearly define the problem and scope, and to develop design requirements. The initial phase involved a literature review on theoretical concepts (value-sensitive design, inclusive design), stakeholder and territory mapping, and site search analytics to establish the domain understanding and scope. In this exploration phase, design ethnography methods, such as observations, interviews, and experience sampling, were leveraged. These methods ensure a deep understanding of the users and their experiences, thus facilitating a more informed design process. The Persona method and Journey maps were used to define the relevant intended users' interactions and experiences, followed by consulting extra literature, the **Emotions Typology** (Desmet & Fokkinga, 2022), **Maslow's hierarchy of needs**, and **13 fundamental psychological needs** (Desmet,2020), the **Design Implications Framework** for this project's context of use was build, to extract **design requirements** from **user needs** and ultimately responding to **user values**.

Research Methods: Various methods were applied throughout the project. Initially, a literature review, stakeholder mapping, and site analytics were used to understand the domain. In the exploration phase, design ethnography, including observations, interviews, and experience sampling, helped gain a deep understanding of user experiences for an informed design process.

Develop – Ideation/Iteration & Deliver – Implementation

Refining the design goal led to idea generation through brainstorming, co-creation, concept mapping, and prototyping. This iterative process involved low-fidelity prototyping, scenario

writing, the PMI decision method, probing, and testing. The final concept was tested with **2** users, reviewed by an expert, and **3** role-players representing the target user. The project concludes with a set of recommendations for further development and market launch tips.

Design Methods: The upcoming project will use a human-centered approach to deeply understand the needs and preferences of the target audience. It begins by setting clear goals and identifying who is involved. This was followed by a flexible process of research and idea testing to clearly define the problem and design requirements

Overview of Ideation and Iteration:

1. First design cycle, ideation (chapter 3.2), aim to find solutions to the explored problems for the users, and resulted into three idea-concepts:
    - Idea-concept 1: Inclusive Infographic Narratives (IIN)
    - Idea-concept 2: Accessible Content Tags (ACT)
    - Idea-concept 3: AI-Enhanced Infographic Accessibility (AIIA)
2. Second design cycle, iteration (chapter 3.3), aim to evaluate potential solutions within a loop of user test, and continuous development from user feedback', which resulted into three concepts for the problem 'infographic unvisualisation":
    - Concept Test 1: Infographic Typology
    - Concept Test 1: Analog Infographic Un-visualization
    - Concept test 3: Digital Infographic Un-visualization
3. Third design cycle, iteration (chapter 3.3), aim to design the whole service concept for Understanding Data Visualization for Inclusive Design, resulted into **user journeys** for:
    - Visually Impaired Social Sciences Student
    - Visually Impaired Medical Student
    - Visually Impaired STEM Student
    - Non-Visually Impaired Classmate
4. Last design cycle, implementation (chapter 3.4) brings together insights form iterations, resulting in a cumulative, integrated service concept for the implementation on a platform called: **Eduvision - Envision for Education Empowering Inclusive Learning Experiences**.

User Research – Data Collection

For the user research a mixed-method approach, that is qualitative and quantitative methods (Creswell et al., 2006), including semi-structured interviews, observations, and surveys. Since a large part of the project was dedicated to user research, essential activities are here highlighted:

1. **Sampling:** A purposive sampling strategy was used to ensure diverse representation within the target user group, which consisted of students with vision impairment aged 18-30. The sample size was carefully chosen to provide a range of perspectives, from various countries mostly based in Europe and North America, while remaining manageable within the project scope.
2. **Data Collection:** Data collection involved the use of multiple tools, including recording devices for interviews, observation sheets, and digital platforms for administering the surveys. This strategy aims to be comprehensive and systematic, thus enhancing the reliability and consistency of the collected data. The overall count of participants in data collection is **2** participants with vision impairment for in-person data collection methods mentioned, **5** sighted participants for design research and validations, **18** survey participants with vision impairment.
3. **Data Analysis:** Qualitative and quantitative data analysis techniques were used. Software tools such as ATLAS.TI were employed for qualitative data, while Qualtrics was used for quantitative data. The analytical frameworks adapted for this study were based on the existing literature and tailored to the specific research context.
4. **Validity and Reliability:** Multiple data sources were used to ensure robust and credible findings, and triangulation was performed. A clear audit trial was maintained, and peer debriefing was conducted to bolster the validity and reliability of the research.
5. **Risk Assessment and Mitigation Plan:** No participant was legally unable to provide informed consent, and all necessary ethical considerations were followed. Data privacy was maintained according to the TU Delft guidelines and GDPR compliance was ensured.
6. **Ethical Considerations:** Informed consent was obtained from all participants, and data were securely stored to maintain confidentiality. Ethical guidelines were strictly adhered to, particularly those related to participant privacy and data protection.

Chapter 3: Design Process

Towards creating a more inclusive education for students with vision impairment, this chapter presents the design process in 4 strategic stages:

***3.1 Exploration**: A deep dive into the students' daily routines sets the stage, synthesizing observations and interviews with insights from a broader global survey and relevant secondary sources.*

***3.2 Ideation**: Here, the information collected transforms into innovative design concepts, addressing users' needs and values identified from the exploration.*

***3.3 Iteration:** Through a cycle of prototyping and feedback, these concepts are meticulously refined based on the design implications, ensuring that they resonate with users' expectations and experience.*

***3.4 Implementation:** The process culminates in bringing the final design to life, with higher prototype fidelity, ready for its introduction into the educational sector, and ultimately to the hands of students it aims to support.*

3.1 Exploration

Introduction:

This chapter delineates the comprehensive design process adopted to enhance the educational experience of students with vision impairments at TU Delft. Starting with a granular observation of daily student life, this study employed a multifaceted approach to gather insights, employing both qualitative and quantitative methods. Semi-structured interviews provided depth and revealed nuanced user experiences, while an international survey expanded the scope of the study, ensuring a diverse range of perspectives. Secondary research methods, including podcast analyses and literature reviews, have contributed to a broader understanding of the systemic challenges faced by the target demographic.

Embracing value-sensitive design principles, the research focused on transforming these insights into a set of actionable design values and criteria. By utilizing the persona method, data were distilled into user archetypes, facilitating the visualization of each persona's journey through the educational landscape, and allowing for the identification of key experiential touchpoints. This meticulous exploration culminated in the construction of a value hierarchy based on Maslow's pyramid, which was instrumental in translating user needs into design implications and setting the stage for defining clear, actionable design requirements. This foundation sets the stage for the later design phases, which delve into the iterative process of design refinement and the eventual implementation of the proposed solutions.

Method:

Divergence in exploration

Exploratory Research: Setting the stage for a deeper dive, this initial phase established a broad understanding of the context within which visually impaired students navigate their educational journeys.

Ethnographic research:

- **Design Ethnography and Observation**: Techniques ranging from active participation to unobtrusive observation (fly-on-the-wall) were employed to gather nuanced insights into the daily realities and challenges faced by the students. This method ensured a realistic depiction of their environment and practices.
- **Interviews**: Focused conversations with students provided personal perspectives, uncovering the layers of their experience. By adopting a semi-structured format, these interviews yielded rich, narrative data while allowing for the exploration of emergent themes.
- **Survey**: To complement the depth of interviews, a structured survey disseminated to a wider audience collected quantitative data, enhancing the breadth of the research. It illuminated patterns and differences across various demographics, capturing a snapshot of a wider experience spectrum.
- **Additional Methods**: Other tools like experience sampling, the critical incident technique, and diary studies gathered through discussions with people around the world through social media, further enriched the data, offering real-time insights and retrospective accounts of significant events.

Throughout, the research maintained a sensitive and informed approach to engaging with participants, acknowledging the unique challenges inherent in working with individuals with visual impairments. By integrating these diverse methods, the section aims to present rich insights that not only resonate with the specific user group but also inform the broader discourse on inclusive design in education.

Secondary research:

- **Content Inventory and Audit**

  To broaden the perspective, the investigation further incorporated secondary research methods, such as reviewing narratives from over 10 podcasts featuring individuals with vision impairment and analyzing articles recounting the educational and social experiences of this demographic. This approach provides a broader perspective of the personal and institutional challenges faced in various educational settings.
- **Secondary Literature Data Analysis on Values**

  value-sensitive design principles, aiming to align the research findings with actionable design values and criteria. This involved an in-depth exploration of how the insights gathered can be codified into meaningful and implementable design specifications.

Convergence in exploration

Persona Journey Mapping:

Utilizing the Persona method, the amassed data were organized into three distinct user personas, each embodying a set of unique values, needs, and experiences. These personas serve as archetypes to facilitate the design process by providing a clear understanding of the target users.

Each persona's educational journey was meticulously mapped, highlighting the significant touchpoints that encapsulate their experiences. These touchpoints, categorized by their positive, negative, or neutral impact, functioned as indicators for areas within the educational system that either supported or hindered user experience.

Design Implications and Requirements

The synthesis of qualitative data provided a definition of concrete design implications and requirements. By mapping the abstract values back to the tangible aspects of the design, the study outlined clear directives for the development of tools and interventions to enhance the educational experience of students with vision impairment.

Ethnographic Research

The Ethnographic Research section delves into the lived experiences of students with visual impairments, utilizing a suite of research methodologies designed to understand their academic and social environments. This inquiry started with exploration through design ethnography and observational studies, distinguishing the subtleties of day-to-day experiences and interactions.

Interviews

The interviews were conducted in a **conversational format**, where the interviewer posed **open-ended questions** to the students, allowing the students to share their **stories**, **challenges**, and **adaptations** during the sessions, each lasting between 60-90 minutes, where students shared their personal experiences, reflecting on their journey from primary school to university and the impact of their visual impairments on their academic pursuits.

Emerged insights:

1. **Impact of Visual Impairments on Studies**: Both students highlighted the time-consuming nature of studying with visual impairments. Reading and comprehending written material was particularly challenging, requiring extra time and effort. One student mentioned the need for enlarged texts and specialized equipment, such as magnifying software and cameras, to aid in reading. The other student expressed the importance of **visual engagement and the limitations of auditory learning alone**.
2. **Accommodations and Support**: The students discussed the accommodations and support they received in their educational institutions. These included individualized tables, specialized equipment, enlarged materials, and additional time for exams. The students expressed gratitude for the support they received, particularly in terms of technological advancements like iPads and enlargement software that facilitated their studies. They also emphasized the **significance of clear communication and understanding** from their peers and instructors.
3. **Challenges in Group Work**: One of the challenges highlighted by the students was participating in group work. They discussed the difficulties in keeping up with the pace of discussions and feeling left behind at times. However, they also mentioned the importance of effective communication and understanding from their teammates, which helped mitigate these challenges.

4. **Adaptability and Resilience**: Both students demonstrated resilience and a strong determination to pursue their academic goals despite the obstacles they faced. They expressed their passion for their fields of study and their desire to make a positive impact in their chosen fields. They recognized the need for adaptability and finding ways to overcome challenges, which included seeking support, utilizing resources, and advocating for their needs.

Interview Conclusions:

The discussions with visually impaired students shed light on their academic journey in higher education. The key takeaway is the significant amount of **extra time needed for their studies** due to their visual impairments. **They rely heavily on accommodations** like enlarged texts and advanced technology such as screen magnification software and tablets to access information.

Additionally, the conversations revealed difficulties these students encounter during group activities, stressing the **importance of effective communication and empathy from fellow students** and educators. Yet, their stories are not just about challenges; they're also about resilience and ambition. These students are dedicated to their education and aspirations, undeterred by their visual limitations.

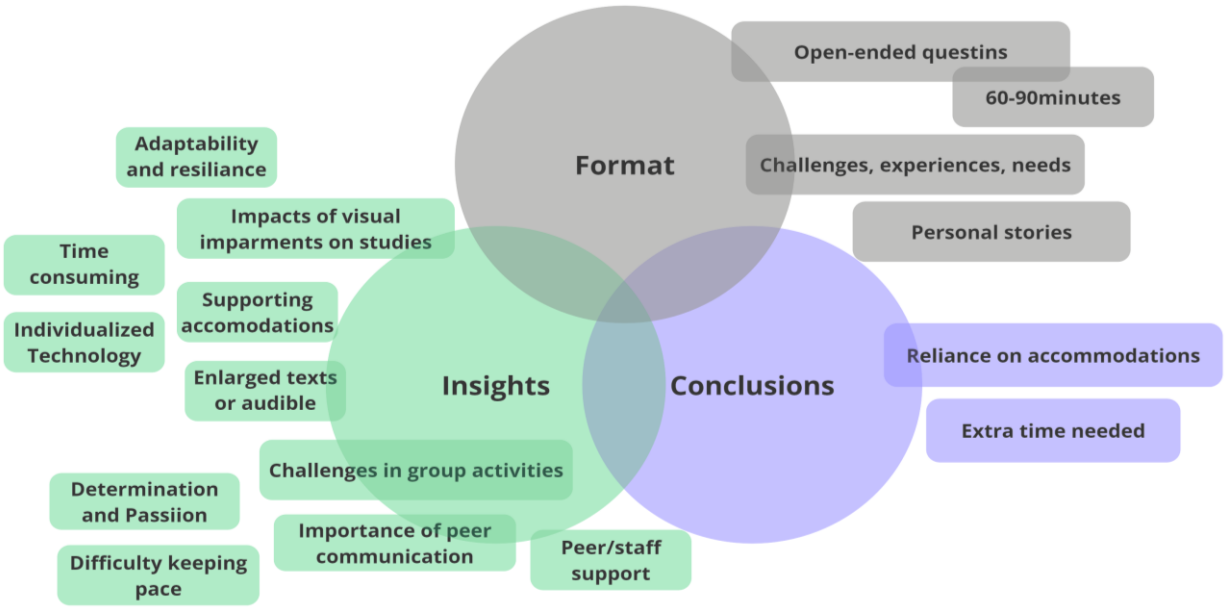


Figure 3-1

Survey

To gain a comprehensive understanding of the challenges and experiences faced by visually impaired students in higher education, a survey was conducted alongside in-person interviews. The survey consisted of 13 questions carefully designed to explore various aspects of the experiences of visually impaired students in higher education. These questions covered a wide range of topics, including the respondents' age, level of education, field of study, level of vision impairment, accommodations utilized, challenges faced, technologies used, navigation strategies, and suggestions for creating a more inclusive educational environment. The survey was distributed to visually impaired students across different educational institutions, resulting in a total of 18 responses.

Survey key insights:

1. **Age and Education Level**: The survey revealed a diverse age range among visually impaired students in higher education. Approximately 15% of the respondents were aged 16-18, 46% were aged 18-25, and 38% were over the age of 26. In terms of education level, the majority of respondents (42.86%) were pursuing a bachelor's degree, followed by 35.71% pursuing a graduate degree, and 14.29% pursuing a doctorate or professional degree.
2. **Fields of Study:** The survey indicated that visually impaired students were engaged in various fields of study. The most commonly reported categories were Arts and Humanities (23.08%), followed by other fields (53.85%), Social Sciences (7.69%), STEM (7.69%), and Business and Administration (7.69%). This diverse distribution reflects the wide range of academic interests among visually impaired students.
3. **Level of Vision Impairment**: The survey respondents reported different levels of vision impairment. The majority (50%) classified themselves as experiencing blindness, followed by 28.57% with conditional vision impairments, 14.29% with severe impairments, and 7.14% with moderate impairments. These varying levels of impairment highlight the diverse experiences and challenges faced by visually impaired students in higher education.
4. **Accommodations Utilized**: The survey highlighted a range of accommodations that visually impaired students found helpful in overcoming challenges associated with their disabilities. Commonly reported accommodations included extra time for exams, screen readers, braille displays, note-takers, and accessible formats for materials. These accommodations play a crucial role in ensuring equal access to educational resources and opportunities.

5. **Challenges Faced**: Visually impaired students identified several challenges in accessing education and other opportunities. These challenges included limited access to information, late arrival of textbooks in accessible formats, transportation difficulties, lack of awareness and understanding from instructors and peers, and discriminatory attitudes and barriers. These challenges underscore the need for greater awareness and support to create a more inclusive educational environment.
6. **Assistive Technologies**: The survey asked participants about technologies or assistive devices they found particularly helpful in managing their studies. Responses included screen readers, braille displays, note-taking devices, and accessible apps for reading and accessing materials. These technologies empower visually impaired students to overcome barriers and engage in their educational pursuits more effectively.
7. **Navigation Strategies**: When navigating new buildings or classrooms, visually impaired students reported various strategies. These strategies included familiarizing themselves with the layout beforehand, using canes for orientation and mobility, asking for assistance or tours, relying on landmarks and mental mapping, and seeking guidance from others. These navigation strategies highlight the resourcefulness and adaptability of visually impaired students in navigating their physical surroundings.
8. **Recommendations for Inclusion**: The survey provided valuable insights into how higher education can be made more inclusive and accessible for visually impaired students. Suggestions included mainstreaming assistive devices to promote their availability to both disabled and non-disabled individuals, raising awareness among instructors about accommodating visually impaired students, regularly checking, and updating campus websites for accessibility, improving transportation options, and providing better sight loss awareness training for staff and students.

Ethnographic Analysis

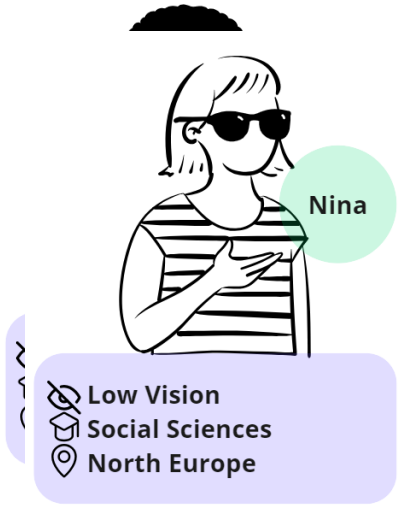
Persona Journey Mapping: identifying experience touchpoints

Personas represent fictional characters that embody specific user characteristics, needs, and goals. They provide a human-centered perspective and help researchers understand the diverse experiences and challenges of their target audience.

By creating personas and journey maps based on survey responses and interviews, the thesis project can derive meaningful insights, identify common patterns and themes, and inform the development of inclusive and accessible solutions for visually impaired students.

From the exploration insights, the following personas are created to demonstrate specific journeys. Journey maps related to each persona, show the interactions, emotions, and touchpoints throughout a particular process or experience.

User Persona 1: Nina

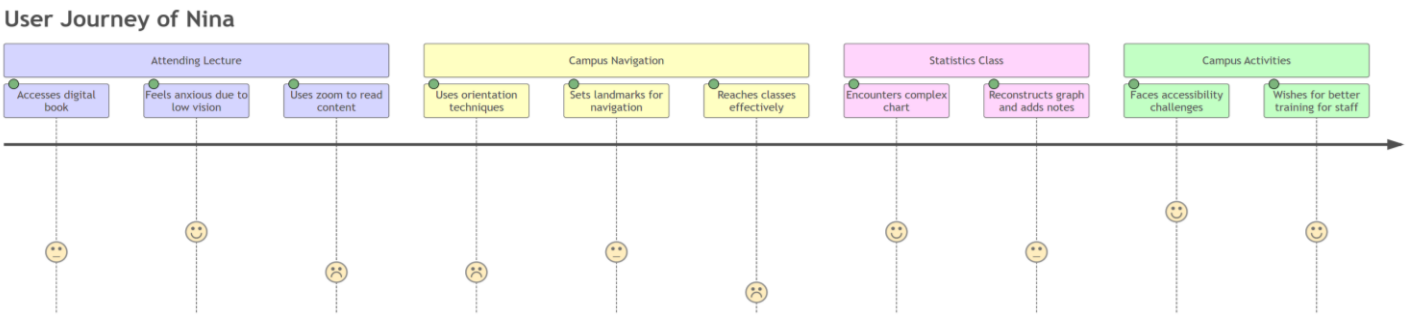


- Age: 25
- Vision: Low Vision
- Field of Study: Social Sciences
- Location: North Europe
- Challenges: Nina faces frustrations in accessing education, software, and devices due to her low vision. She feels anxious when it comes to digital books and struggles with orientation and navigation on campus. Zooming in on screens and setting landmarks helped her navigate and read details on charts. However, she still experiences difficulties in reconstructing graphs and adding her notes. She feels tired and wishes for better accessibility. Nina believes that instructors should have awareness of accommodating visually impaired students, and she values training for staff and lecturers to improve accessibility.

User Journey 1: Nina

1. Nina attends a social sciences lecture and struggles to access the digital book provided. She feels anxious and relies on zooming in on the screen to read the content.
2. During a campus tour, Nina uses orientation and navigation techniques to set landmarks and find her way around. This helps her reach her classes and navigate the campus effectively.
3. In statistics class, Nina encounters a complex chart. She reconstructs the graph and adds her notes to understand the details more clearly.
4. Nina faces missed opportunities in campus activities that require orientation and mobility. She wishes for better accessibility and training for staff and lecturers to improve understanding and inclusion.

Figure 3-2



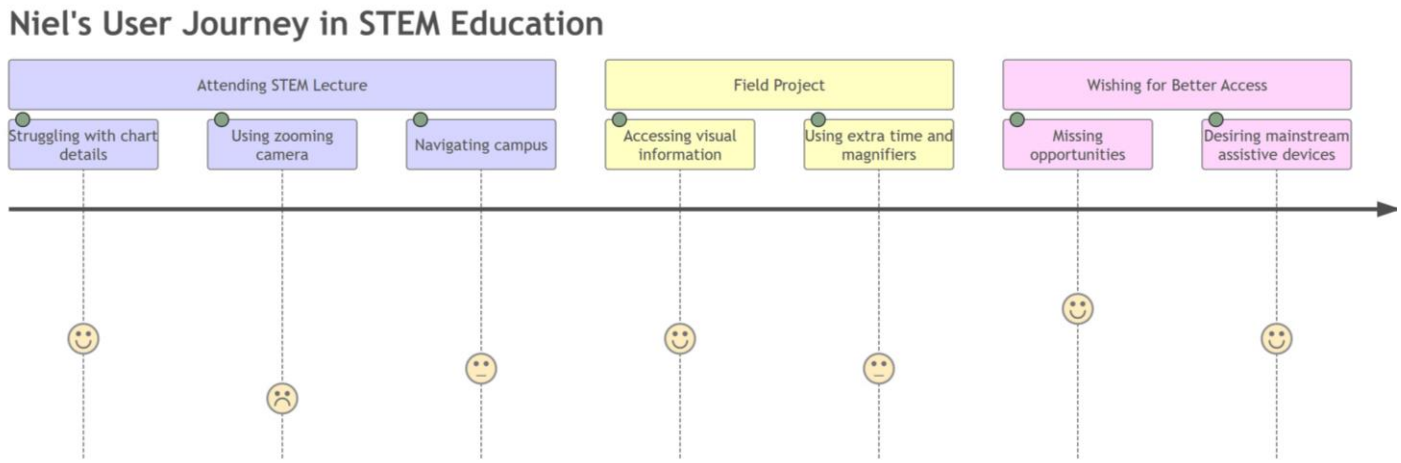
User Persona 2: Niel

- Age: 22
- Vision: Conditional Vision
- Field of Study: STEM
- Location: North America
- Challenges: Niel faces frustrations in accessing education, software, and devices due to his conditional vision. He relies on zooming cameras and orientation and navigation guidance on campus. However, he often feels lost and struggles with reading details and connections on charts. He relies on extra time and magnifiers when there is no access to visual information. Niel feels he misses opportunities in field projects and wishes for more mainstream access to assistive devices for both disabled and non-disabled individuals.

User Journey 2: Niel

1. Niel attends a STEM lecture and struggles to read the details and connections on complex charts. He uses a zooming camera to magnify the content and relies on orientation and navigation guidance on campus to find his classes.
2. During a field project, Niel faces challenges in accessing visual information. He uses extra time and magnifiers to overcome the barriers and complete his tasks.
3. Niel feels he misses opportunities in field projects and wishes for more mainstream access to assistive devices that would enhance his understanding, inclusion, and innovation.

Figure 3-3



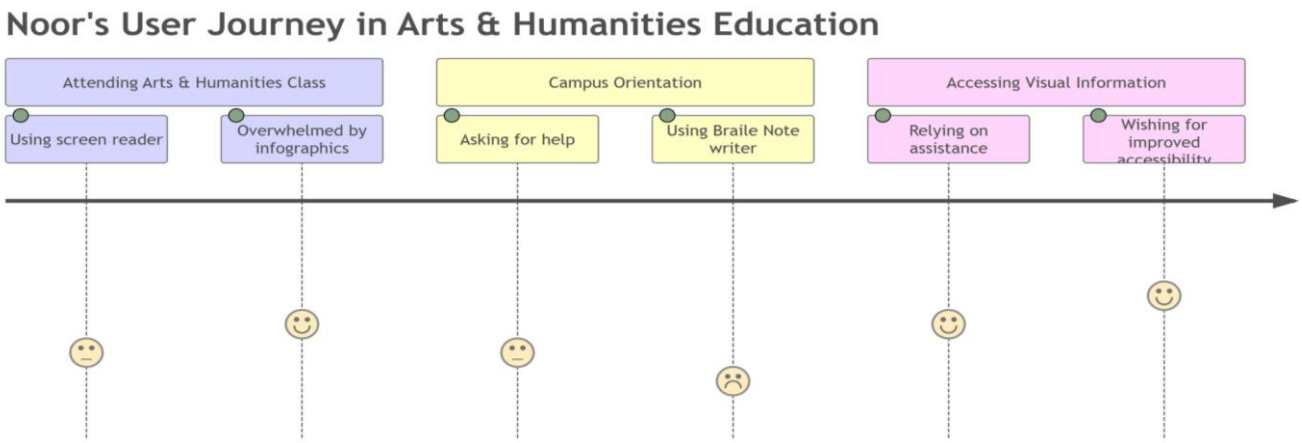
User Persona 3: Noor

- Age: 28
- Vision: No Vision
- Field of Study: Arts & Humanities
- Location: South Europe
- Challenges: Noor faces frustrations in accessing education, software, and devices due to her lack of vision. She feels overwhelmed by details and relies on screen readers for assistance. Orientation and navigation are challenging for her, and she often asks for help or uses a Braile Note writer. She feels confused when learning infographics and relies on asking for help in situations where there is no access to visual information. Noor believes there is a lack of accommodations and highlights the need for marked road crossings, audible crosswalks, and better school services in rural areas.

User Journey 3: Noor

1. Noor attends an arts and humanities class and relies on a screen reader to access course materials. She finds it overwhelming to comprehend the details presented in infographics and visualized data.
2. During campus orientation and mobility sessions, Noor asks for help and uses a Braile Note writer to navigate her surroundings and overcome orientation challenges.
3. Noor faces missed opportunities in accessing visual information and relies on asking for help to understand the content. She wishes for improved accessibility, including digital books and better campus orientation and mobility services.

Figure 3-4



Ethnographic Synthesis

The personas and journey maps created provide valuable insights into the challenges faced by visually impaired students in higher education.

- Key insight is difficulty understanding complex visualized data like charts and graphs, which is crucial for academic success.
- Solutions like alt text have limitations in conveying nuances of visualizations. Innovative approaches needed.
- Focusing on improving accessibility of visualized data can enhance learning experience and empower visually impaired students.
- Personas and maps show need for:
    - Better access to digital course materials
    - Enhanced campus navigation and orientation
    - Training for staff to improve inclusion
    - Mainstream access to assistive devices

The ability to comprehend and extract insights from visualized information is crucial for academic success across various disciplines.

By focusing on improving the accessibility of visualized information, higher education institutions can enhance the learning experience and empower visually impaired students, and therefore more inclusion for these students.

Secondary Research and Analysis

Secondary Literature Data Analysis

Conducting secondary data analysis of existing literature provides valuable insights without needing new direct participant research. This approach reduces redundancy and waste while still generating new perspectives, especially when time and participant resources are limited.

The literature analysis revealed insightful correlations between different research fields and topic areas:

- The user personas developed correlate strongly to findings from a study on distracted and confused selective attention under load. This connection provides relevance to the persona development.
- Research exploring the relationship between personality traits and employment status of visually impaired individuals exhibits strong correlation to motivation and personality theories like Maslow's hierarchy. This links to a key user segment.
- A correlation was found between academic attainment data of visually impaired students in distance education programs and the field of motivation and personality. This has significance for educational attainment.

Key insight emerged from the in-depth literature analysis:

- The analysis contributed to a deeper understanding of the unique challenges and needs facing visually impaired students in higher education environments.

The findings will directly inform subsequent stages of the human-centered design process by identifying areas of focus. Examples of the correlation (more on **Error! Reference source not found.**):

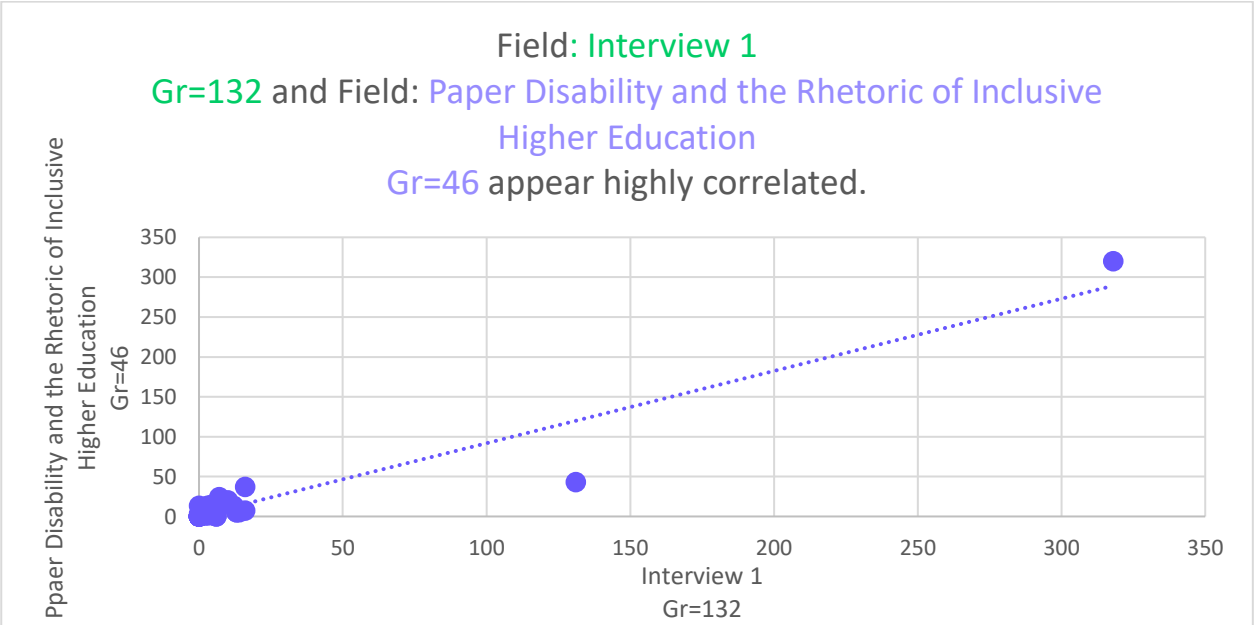


Figure 3-5

Based on the synthesis of the contextual research conducted, several key results have emerged:

1**. Understanding of Student Needs**: Students with visual impairments express a desire for tools and environments that affirm their identity and facilitate their autonomy. The need for belonging and personal acceptance is evident across the board.

2. **Gaps in Current Design**: There is a notable gap in the representation of visually impaired students in educational material design. Tools and services often lack the inclusivity that is required for these students to thrive.

3. **Opportunities for Improvement**: The opportunity lies in designing solutions that address the **specific needs** of visually impaired students. The use of **adaptive technologies** and the incorporation of universal design principles are areas for development.

Content Inventory and Audit

The content audit aggregates personal narratives into a collective understanding of the needs of visually impaired users. Analyzing sources like Miso Kwak's essay at HGSE and the 'Working Blind' podcast series provides deep insights into the lived experiences of individuals with visual impairments. These narratives highlight critical themes, including the integration of disability into personal identity and the importance of genuine self-representation. The detailed content from these narratives is provided in the appendices.

Personal Narratives Analysis:

Personal narratives, in the form of love and breakup letters, serve as intimate portrayals of students' relationships with their educational journey. The love letters express a longing for connection and personal development, while the breakup letters reveal a demand for emotional respect and validation of individuality. These metaphorical letters shed light on the fundamental aspirations and emotional needs of visually impaired students within their educational contexts. Key emotional touchpoints from these letters are identified as indicators of the deeper values visually impaired students seek in their education. Examples in the appendices.

Values discovered in this metaphoric love letter are:

- Need of Belonging
- Need of Purpose

- Need of Personal acceptance, Growth and Strength

Versus values discovered in this metaphoric breakup letter:

- Need of emotional stability
- Need of appreciation for personal beliefs and differences

Secondary Research Synthesis

The main insights from the content audits and personal narratives include:

- The importance of **embracing blindness as part of one's identity** rather than viewing it as an obstacle to be overcome.
- The significance of **authentic self-representation** in educational settings and materials.
- **Blind individuals may require more time** to study due to the lack of accessible study materials.
- There's a need to **communicate blindness with confidence**, embracing both positive and challenging aspects.
- **Awareness and education** about blindness should be integrated into the broader educational environment.
- **Recruitment processes** often fail to accommodate the visually impaired, suggesting a lack of awareness or preparedness among employers.
- **Workplace accommodations**, though sometimes simple, can be challenging to implement effectively.
- **Job opportunities for visually impaired individuals** are crucial in overcoming initial employment barriers.

Requirements for Design Implications

These insights evoke the following requirements to be investigated for Design implications:

- Designing a specialized resource center for students with vision impairment.
- Incorporating braille and audio options into standard learning materials.
- Creating a participatory feedback system for ongoing design improvement.

Concept Mapping: Towards Inclusive Design Implications

Concept mapping emerges as a pivotal method in understanding the intricate web of experiences, needs, and values of students with vision impairment. It is a qualitative framework that weaves together behavioral attitudes and design implications to guide inclusive educational strategies. This concept map serves not only as a visualization of interconnected elements but as a reflective tool that aligns design efforts with research objectives.

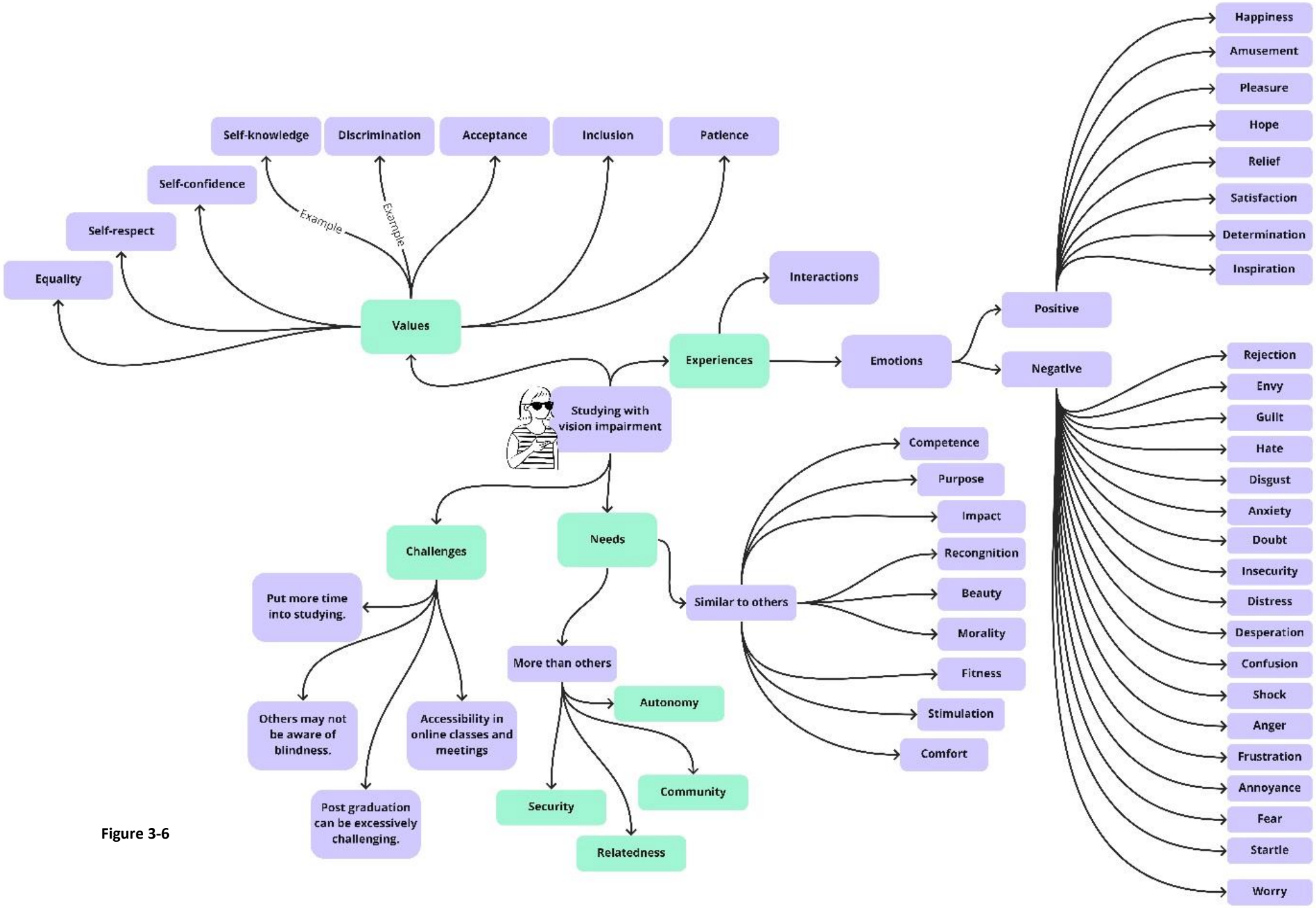

Self-knowledge
Discrimination
Acceptance
Inclusion
Patience
Self-confidence
Self-respect
Equality
Example
Example
Values
Interactions
Experiences
Emotions
Positive
Negative
Happiness
Amusement
Pleasure
Hope
Relief
Satisfaction
Determination
Inspiration
Rejection
Envy
Guilt
Hate
Disgust
Anxiety
Doubt
Insecurity
Distress
Desperation
Confusion
Shock
Anger
Frustration
Annoyance
Fear
Startle
Worry
Studying with vision impairment
Challenges
Needs
Put more time into studying.
Others may not be aware of blindness.
Accessibility in online classes and meetings
Post graduation can be excessively challenging.
More than others
Similar to others
Autonomy
Community
Security
Relatedness
Competence
Purpose
Impact
Recongnition
Beauty
Morality
Fitness
Stimulation
Comfort

Figure 3-6

Insights from the Concept Map

- **Core Values**: At the heart of the concept map are core values — Equality, Self-respect, Self-confidence, and Self-knowledge. These values are fundamental in fostering an environment where acceptance and inclusion replace discrimination, promoting patience and understanding within the educational landscape.
- **Experiential Interactions**: Students' experiences are greatly influenced by their interactions within educational settings. The range of emotions evoked by these interactions is vast, extending from positive (Hope, Satisfaction) to negative (Anxiety, Rejection). This emotional spectrum is critical for identifying areas where design can play a role in enhancing positive experiences and mitigating negative ones.
- **Navigating Challenges**: The concept map outlines specific challenges faced by students with vision impairment, such as the intensified effort required in studying and potential post-graduation hurdles. Addressing these challenges necessitates recognizing and fulfilling needs that might be greater than those of their sighted peers.
- **Meeting Needs**: Beyond accessibility and security, the map underscores the need for autonomy and a sense of community — essentials for creating a support system that empowers students with vision impairment.

Gaps and Opportunities

- **Aspirations for Normalcy**: A notable insight is the desire for normalcy — ensuring that needs specific to vision impairment are met without segregating these students from the community. This insight presents an opportunity to create solutions that integrate rather than isolate.
- **Beyond Basic Needs**: The map highlights aspirations that transcend basic needs, like the desire for recognition and to make an impact. It points to the opportunity for higher education institutions to foster environments where students with vision impairment can thrive academically and personally.

Requirements for Design Implications

- **Addressing Barriers**: The concept map has identified barriers — from inaccessible materials to physical limitations in educational environments. Design implications include the

development of accessible digital content and learning environments, and the incorporation of assistive technologies.

- **User-Centered Design Approaches**: The importance of involving students with vision impairment in the design process is evident. Adopting user-centered approaches ensures the creation of solutions grounded in real-world experiences.
- **Value-Sensitive Design**: A value-sensitive design approach is imperative, where ethical and social values are embedded within the design process, acknowledging the importance of inclusivity and diversity.
- **Impact of Inclusive Design:** The concept map itself, by identifying and connecting these various dimensions, provides a strategic vision for the thesis research. It becomes a guiding framework for subsequent design phases, ensuring that solutions are not only innovative but also deeply empathetic and inclusive.

Design implications

The design implications discussed in this chapter extend the exploration of personas and user journeys, highlighting the inadequacies of simple solutions like alt text in conveying complex information for visually impaired students. The identification of these challenges underpins the need for innovative methods to enhance data accessibility—this is where the creation of tactile graphics, sonification, and interactive tools becomes essential. The integration of these solutions into the design process can transform the learning experience by empowering students to grasp complex concepts more effectively.

The value-sensitive design approach, rooted in the integration of human values within technology, becomes particularly pertinent when considering AI's role in products like those from Envision. A multifaceted research approach—conceptual, empirical, and technical—is paramount for embedding values that resonate with users, particularly when designing for inclusivity.

Design Principles Correlation with User Values

1. **Accessibility**: Prioritizing ease of use to enable students with disabilities to access information efficiently.

2. **Independence**: Facilitating self-sufficiency with tools that promote autonomous navigation and interaction.
3. **Inclusiveness**: Ensuring all students feel represented and supported, with no barriers to access.
4. **Ease of Use**: Creating intuitive user interfaces that simplify complex tasks.
5. **Customization**: Offering personalization options to accommodate individual preferences and needs.
6. **Safety**: Designing with the safety of visually impaired users in mind, especially in new or unfamiliar settings.
7. **Affordability**: Considering the financial constraints of students to ensure broad accessibility.
8. **Support**: Providing robust support systems to aid in overcoming educational hurdles.
9. **Flexibility**: Ensuring adaptability to cater to a range of learning environments and situations.
10. **Integration**: Seamless compatibility with existing technologies to avoid disruptions.
11. **Empowerment**: Enabling students to feel confident and capable in their academic endeavors.
12. **Collaboration**: Facilitating effective communication and cooperative learning.
13. **Growth**: Supporting the pursuit of personal and professional aspirations.

Maslow's hierarchy of needs Correlation with User Values

Aligning these design principles **with Maslow's hierarchy of needs** underscores the potential impact on the emotional well-being of visually impaired students. For instance:

- **Security and Safety**: Accessibility and safety features provide a stable, risk-free environment, fostering a sense of security.
- **Belongingness and Love**: Inclusiveness and ease of use contribute to a community feeling, fulfilling the need for connection.
- **Esteem and Self-actualization**: Empowerment and growth opportunities foster a sense of achievement and the realization of personal potential.

So, a successful design for visually impaired students in higher education hinges on the holistic integration of user-centric values. These values serve as guiding principles for developing technologies that not only meet functional requirements but also resonate on a psychological level, addressing fundamental human needs. It is this alignment that will ensure the creation of meaningful, empowering, and inclusive educational experiences.

Figure 3-7

13 fundamental psychological needs Correlation with User Values

The correlation between specific design values and the 13 fundamental psychological needs (Desmet & Fokkinga, 2020) outlines a comprehensive approach to address the holistic experience of students with visual impairments.

- **Accessibility, independence, safety, and support** correspond to the need for **security and safety** , fostering a safe academic environment.
- **Customization and personalization** cater to the need for **self-expression and identity**, allowing students to tailor their educational tools, asserting their individuality (Dorst & Cross, 2001)
- **Inclusiveness, ease of use, and quality** are pivotal for **connection and love**, ensuring students feel integrated and .
- The **need for certainty** is met through **affordability, flexibility, and integration**, providing students with control and stability .
- Lastly, **empowerment, growth, and creativity** are essential for students' **growth and self-actualization**, aiding in their personal and academic development .

These correlations serve as a checklist to assess the applicability and significance of future design concepts, ensuring they resonate with the emotional and psychological needs of visually

impaired students. By grounding design in these values, we aim to craft products and services that are not just functional but also empathetically aligned with user needs.

Design Implications Framework

Concluding from the **Design Principles**, **Maslow's hierarchy of needs**, and **13 fundamental psychological needs** correlation with the **needs of students with vision impairment:**

- To deliver an effective service, it's paramount to ground the design in a deep understanding of the service's purpose, demand, and the service provider's delivery capabilities.
- The customer's needs should be the north star of service design, taking precedence over the internal needs of the business.
- Breaking down services into manageable sections allows for tailored solutions that can meet the diverse needs of all users in various contexts.
- Accessibility is non-negotiable; the service must be universally accessible, embracing all abilities and disabilities.

The table aligning Maslow's hierarchy of needs with design implications ensures that educational technologies for visually impaired students are developed with empathy, addressing core psychological needs, ensuring safety, promoting inclusiveness, enabling independence, and fostering self-actualization through empowerment and quality.

Table 3-1

Psychological Need (Buttom up) ↓	**Ethical Value** ↓	**Design Implication**	**Requirement**	**Measurement**
Physiological needs (air, water, food, shelter, sleep, clothing, reproduction)	**Accessibility**	**Usability**	The design should be **easy to use** and **intuitive** for visually impaired students.	• **amount of time** it takes to complete tasks • **number of errors** made during navigation • **level of frustration** expressed by the student
Safety needs (Personal security, employement, resources, health, property)	**Certainty**	**Safety**	The design should **prioritize safety and security** for visually impaired students, especially in **unfamiliar environments**.	• number of **incidents** or accidents that occur • **level of risk** associated with different tasks • the **effectiveness** of safety features
		Affordability	The design should be affordable and **cost-effective**, especially given the limited resources of visually impaired students.	• **cost** of the product or service compared to **alternative options** • level of financial burden on students • **impact** of cost on student **satisfaction**
		Support	The design should provide support and **assistance** to visually impaired students, especially in navigating the challenges they face as students with disabilities.	• **number of support requests** received • level of **satisfaction** with the support provided • **impact** of support on student **success**
Love and belonging (friendship, intimacy, family, sense of connection)	**Inclusiveness**	**Inclusiveness**	The design should promote inclusiveness and provide a **sense of belonging** for visually impaired students.	• **level of engagement** and participation in class discussions • **number of social interactions** with peers • **feedback** received from students regarding their sense of belonging
		Integration	The design should **integrate seamlessly with existing tools and technologies**, to minimize friction and disruption to visually impaired students' daily routines.	• level of **integration with other tools and technologies** • number of **errors or disruptions** encountered during integration • impact of integration on **task completion**
	Equity	**Accessibility**	The design should provide **easy access** to educational **resources** and **services** for visually impaired students.	• **time it takes to access** course materials • **number of steps** required to complete a task • **level of support** required
Esteem (respect, self-esteem, status, recognoition, strength, freedom)	**Independence**	**Independence**	The design should enable visually impaired students to **navigate and interact with their environment** independently.	• **amount of assistance** required to complete tasks • **time it takes to navigate** a new environment • **level of confidence** expressed by the student
	Flexibility	**Customization Personalization**	The design should allow for **personalization** and **customization** to meet the unique needs of visually impaired students.	• **number of customizations** made by each student • **level of satisfaction** with the customization options • **impact** of customization on **task completion**
Self-actualization (desire to become the most that one can be)	**Empowerment Growth Creativity**		The design should empower visually impaired students to be **confident**, **competent**, and **capable**, especially in their academic and professional pursuits.	• level of **self-efficacy** expressed by students • level of **confidence** in completing different tasks • the impact of the design on student **success**
	Quality		The design should be of **high quality** and **durable**, especially since visually impaired students may have to rely on it **frequently**.	• **level of satisfaction** with the quality of the product • number of **repairs** or **replacements** required • **durability** of the product over time

Value Checklist

As a result of design Implications framework, identified needs translated to the bellow value checklists in order to achieve inclusion for this specific design context:

- Ensure the service is **accessible** and inclusive for visually impaired students.
- The service must **eliminate barriers** and **foster inclusiveness** for visually impaired students.
- Design **simplicity** and **intuitiveness** are essential for **ease of use** by visually impaired students.
- Allow for **personalization** to accommodate the **unique needs** of visually impaired students.
- **Prioritize safety and security**, particularly in new or unfamiliar settings.
- The service must be **financially attainable** for visually impaired students.
- Provide **support** to assist visually impaired students through their educational journey.
- Offer **flexibility** to adapt to the varied academic and personal challenges visually impaired students encounter.
- Encourage **collaboration** among visually impaired students, educators, and other educational stakeholders.

Design Requirements

- Clearly **define stakeholder roles** to ensure a comprehensive consideration of needs within the service design.
- Create a **detailed service blueprint** outlining the vision, deliverables, processes, stakeholders, and necessary tools.
- Value addition for the customer should be the focus of all activities, with a process-centric approach over product-centric.
- Consider **accessibility, usability, and inclusion as a collective** when designing to optimize the user experience.
- Identify and mitigate design-related **risks** throughout the service design process.

Evaluation and Measurement of Values

Establish concrete metrics and indicators to assess the effectiveness of the design:

- **Accessibility** can be measured by the efficiency and support needed to access resources.
- **Independence** metrics could include the level of assistance needed and confidence in navigating new environments.
- **Inclusiveness** can be gauged through engagement, social interactions, and students' feedback on their sense of belonging.
- For **ease of use**, measure the time to complete tasks, error rates, and user frustration levels.
- **Customization** success can be quantified by the number of personalized adjustments and user satisfaction.
- **Safety** is measurable through incident rates and the effectiveness of safety features.
- **Quality** can be tracked via product satisfaction and its long-term durability.
- **Affordability** can be assessed by comparing costs and evaluating the financial impact on students.
- **Support** quality can be evaluated by the number of requests and satisfaction with the assistance provided.
- **Flexibility** can be measured by the design's adaptability to different needs and contexts.
- **Integration** success can be measured by the level of compatibility with other tools and the impact on daily routines.
- **Empowerment** can be evaluated by students' self-efficacy, confidence, and academic success.
- For **collaboration**, assess the facilitation of communication among all stakeholders.

Conclusion:

The exploration process in the design chapter has provided valuable insights that will guide the next design phases. The research used various methods like observations, interviews, surveys, and content analysis to understand the experiences of visually impaired students.

The key findings are:

- **Visually impaired students have difficulty understanding complex visual information like charts and graphs. This limits their ability to fully access educational content.**
- There are opportunities to improve accessibility through new **solutions** like **tactile graphics**, **sound-based learning tools**, and **interactive models**.
- **Concept mapping** linked the research insights to **broader human values** like **inclusion**, **independence**, **confidence**, and **personal growth**.
- **Value-sensitive** and **human-centered design** approaches are important to develop solutions based on **real user experiences**.
- The **design implications** outline clear guidelines, and the evaluation metrics provide ways to measure the **effectiveness of new concepts**.
- Continued user involvement through **testing prototypes** is essential to **keep empathy** and insight strong throughout the design process.

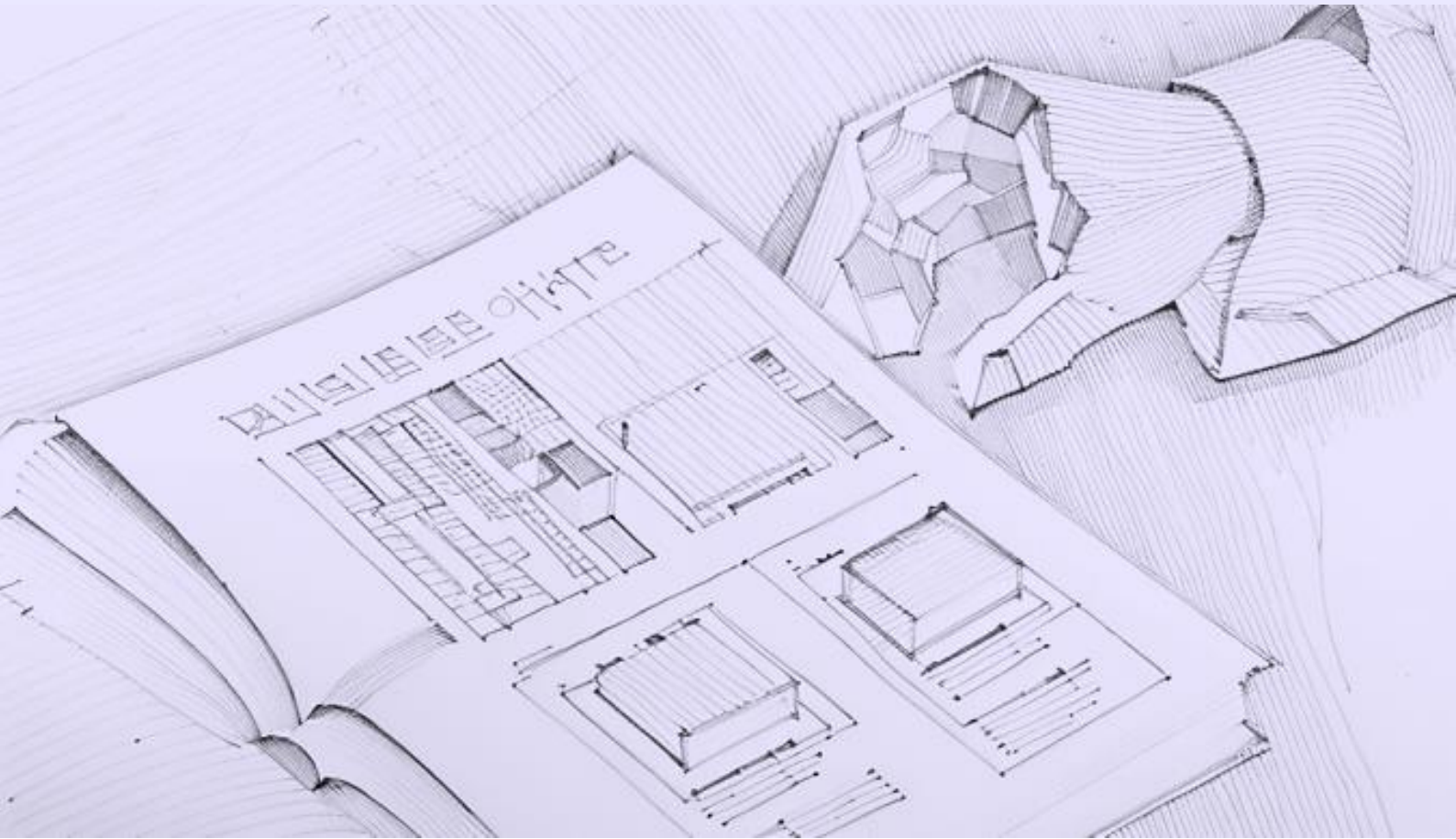
By laying groundwork, the exploration chapter has achieved its goal - gaining a deep understanding of user needs to guide the design of inclusive educational experiences. The insights gathered will direct the idea generation and concept iteration for tackling the ultimate design goal: improving sense of inclusion in students with vision impairment.

3.2 Ideation

Introduction:

The ideation process enables insights to transform into innovative concepts that address users' needs. Unconstrained brainstorming produces abundant ideas, before the design implications framework focuses them into aligned solutions tailored to core values including accessibility, independence, and personalization.

Notable ideas emerged centered on reimagining how visual information could become more accessible through conversion into multi-sensory inclusive formats. "Accessible Content Tags" (ACT) offer audio and haptic versions of infographics via QR codes, while "AI-Enhanced Infographic Accessibility" (AIIA) employs AI to automatically narrate visual data. Such concepts highlight technology's promise as an ally in inclusive education.



Method:

Divergence in Ideation:

The brainstorming phase generates an extensive list of approximately 90 ideas with a wide range, without immediate constraints or criticism. Then organized into distinct categories of feasibility using a mind map, which was structured around the previously identified design implications. To encourage lateral thinking and prevent creative stagnation, a session dedicated to co-creation was arranged, where **5 participants** engaged in free-form thinking, often using prompts or creative exercises to inspire new concepts. Techniques inclu*ded:*

- **Flower Association**: An exercise where a central idea is expanded upon with associated concepts, similar to mind mapping, to explore potential avenues for innovation.
- What Ifs: This speculative technique involves posing hypothetical scenarios to challenge existing assumptions and spark new ideas.
- **Bodystorming:** Role-playing activities that simulate interactions with prototypes or services to explore design solutions
- **Bodystorming**: Role-playing activities that simulate interactions with prototypes or services to explore design solutions.
- **SCAMPER**: A creative tool that prompts questions for modifying existing ideas or products.

The outputs from these exercises were then compiled into a concept map, synthesizing them into overarching concepts.

Convergence in Ideation

User validation is crucial to concepts. This was achieved by presenting concepts to users within scenario-based narratives that mirrored real-life applications. The feedback obtained from this exercise was instrumental in guiding further iterations, ensuring that the evolving designs remained aligned with users' needs and experiences within their educational environments.

Understanding Data Visualization

In the pursuit of creating educational tools that are inclusive for students with vision impairment, it's important to learn how visual information like infographics is put together. This helps to come up with new ways to present the same information in forms that everyone can understand.

Steps to Understand Data Visualization and Creation:

1. **Topic Identification**: The inception of an infographic begins with selecting a pertinent topic that resonates with the intended audience.
2. **Data Compilation**: This involves meticulous research to amass supportive data, ensuring it is sourced ethically and with the necessary permissions.
3. **Core Message Determination**: Distilling the information to define a core message that is both potent and comprehensible to the audience.
4. **Layout Decision**: A visually engaging layout is then chosen to guide the viewer effortlessly through the information.
5. **Design Drafting**: Preliminary designs are sketched, considering aesthetics and clarity.
6. **Inclusion of Visuals**: Visual elements like charts and images are incorporated to bolster the narrative, with mindful color and font choices.
7. **Text Crafting**: The accompanying text is crafted to be succinct and lucid, avoiding technical jargon to maintain accessibility.
8. **Review and Refinement**: The infographic undergoes a rigorous review to ensure it accurately conveys the intended message, making edits where necessary.

Revised Design Goal and Research Question

Reflecting on the initial aim to enhance inclusivity for students with vision impairment, the **design goal** has evolved to focus on **“enabling access to visual educational content”**.

This leads to a pivotal research question: **How can visual content be transformed into a non-visual format without losing its essence?**

Brainstorming and Ideation

The ideation chapter describes the process of coming up with about 100 different ideas aimed at helping students with vision impairment. This part of the project was about thinking broadly and deeply to find a range of solutions, from simple, practical ones to big, innovative ideas for the future.

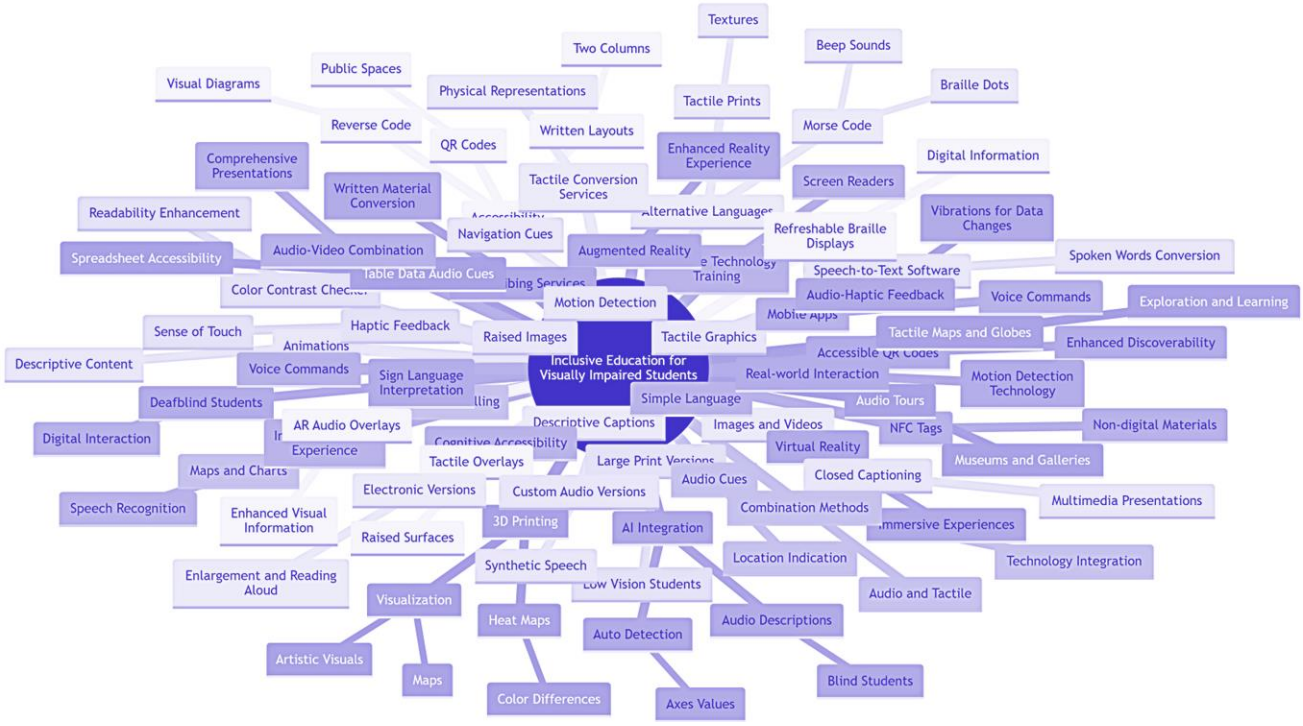


Figure 3-8

Brainstormed Ideas in Categories

The brainstorming resulted a diverse set of ideas, each category summarizes different facets of **accessibility** and **interaction**:

- **Enhancing Readability and Navigation:**
    - Ideas like dual column written layouts for easy magnification.
    - Attachment of QR codes to public spaces for orientation, enhancing autonomous navigation.
- **Tactile and Sensory Innovations:**
    - Proposals for tactile print creation and 3D printing techniques to convert data visualizations into touchable formats.

    - Exploring temperature as a medium to convey information, such as using heat to differentiate data points.
- **Technology Integration:**
    - Utilization of artificial intelligence for automated detection of axes and values in visual representations.
    - Development of tools for audio description, ensuring that visual content is translated into descriptive narratives.
- **Futuristic Interactions:**
    - Gesture-based interfaces allowing students to navigate information through intuitive movements.
    - Advanced applications such as binaural audio for spatial understanding and haptic feedback devices for tactile interaction.
- **In-Depth Synthesis and Insights:**
    - The brainstormed ideas suggest a clear trend towards multi-modal learning experiences. Here's a closer look at the emerging themes:
- **The Push for Multi-sensory Education:**
    - There's a drive towards leveraging senses beyond sight and hearing to include touch, and potentially even smell and taste, providing a richer educational experience for students with vision impairment.
- **Artificial Intelligence as a Catalyst:**
    - AI surfaces as a cornerstone technology, anticipated to revolutionize the educational experience through personalized voice-guided systems, image recognition, and adaptive learning platforms.
- **Embracing Immersive Technologies:**
    - Virtual and augmented realities are acknowledged for their potential to simulate environments and concepts, offering students with vision impairment an unparalleled depth of interaction with educational content.

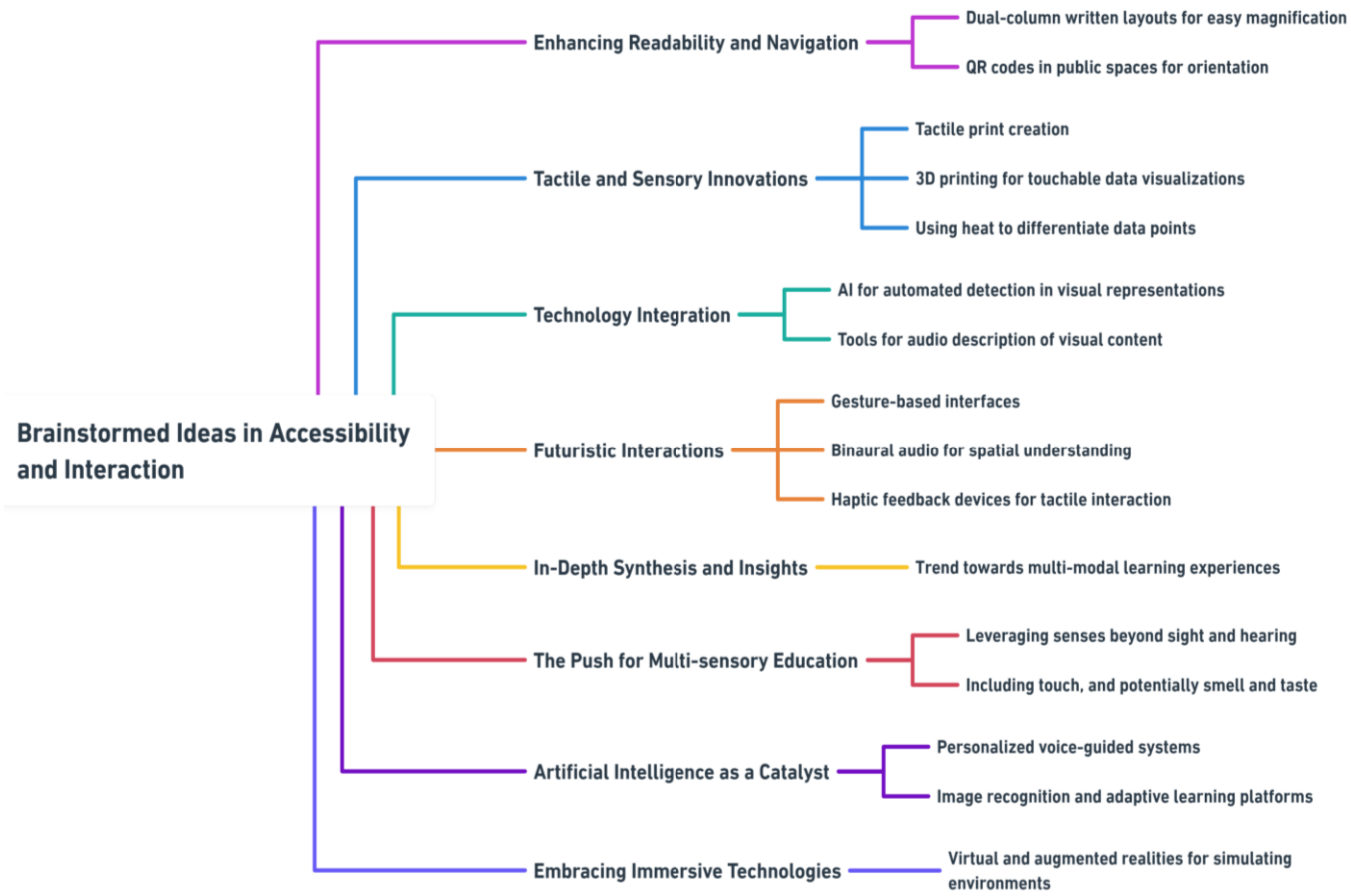


Figure 3-9

Guideline for Viable Alternative to Data Visualizations

When creating non-visual versions of infographics for blind students at the university level, it's important to consider the **complexity and level of detail** in the original infographic (which is one of the most repeated pain point for the users), as well as the needs and **preferences (that is an underlaying need, later translated to personalization value in the design implications checklist for evaluation of the design concepts)** of the students themselves. Potential **viable alternative formats** to a visualization among all the ideas include:

1. **Text descriptions**: This is a **simple and viable** option for representing data in a non-visual way and can be an effective way to convey the **key insights and trends** in an infographic.
2. **Audio descriptions**: for university-level infographics, particularly for more **complex or detailed** visualizations. Using a narrator or voiceover artist to provide audio descriptions of the visual elements, along with key insights and trends, can help to make the information more accessible and **engaging** for blind students.

3. **Haptic feedback**: haptic feedback can be an effective way to represent data in a non-visual way. This could involve using **vibrations** or other **physical sensations** to represent **different data points** or trends, allowing students to "**feel**" the information in a tactile way.
4. **Smell or taste**: For certain types of data, it may be possible to use smell or taste to represent information in a non-visual way. For example, a data visualization that represents different types of food could be accompanied by the actual smells or tastes of those foods, allowing users to experience the information in a different sensory modality.
5. **Virtual or augmented reality**: For more advanced applications, virtual or augmented reality could be used to create non-visual representations of data. For example, a user could wear a VR headset or use an AR app to explore a three-dimensional representation of the data, with different colors, shapes, or sounds used to represent different elements of the visualization.

To describe these visualizations, several languages and codes can be utilized:

- Spoken human languages, for broad accessibility.
- Computer coding languages, which may appeal to tech-savvy students.
- Braille, for tactile reading.
- Morse Code, potentially through audio or haptic feedback.

Co-Creation Session

The Co-creation session was held with a group of 5 participants. The problem as given was: "**challenges for students with vision impairment**". Through techniques like purging, flower association, and SPARK keywords, the problem was reframed as: "**How to create a non-visual interpretation of visual information or concepts?"**

The ideation process involved purging on the reframed problem, using the criminal round technique to get out of context and force-fit those associations back into the problem to generate creative ideas. The top ideas were chosen using the Hits and Dots method.

They included ideas like using AI to describe environments, a navigation assistant, and a sighted

volunteer network. The top four ideas were visualized in poster format:

1. **Neuro link brain connector:**

   The idea is that it connects to the brain's neurons and visualizes the world for people who are blind. The key points about this device are:

   - It is not visible to others and makes blind individuals recognizable and equal to others.
   - There is no surgery required for implementation; it can be implemented in 10 minutes.
   - The device can train the brain to enable visually impaired to gradually see without the Neuro Link.

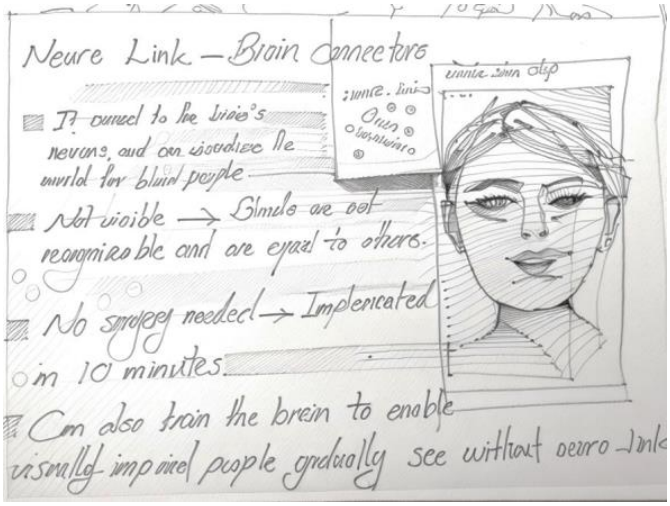


Figure 3-10

2. **Upsy-dupsy:**

   It is designed to connect with neurons and visualize the world for blind people. It features a "touch button" for 4-dimensional elevation codes. The system includes a binary codes interpreter, presumably to translate binary code into a format understandable by the user.

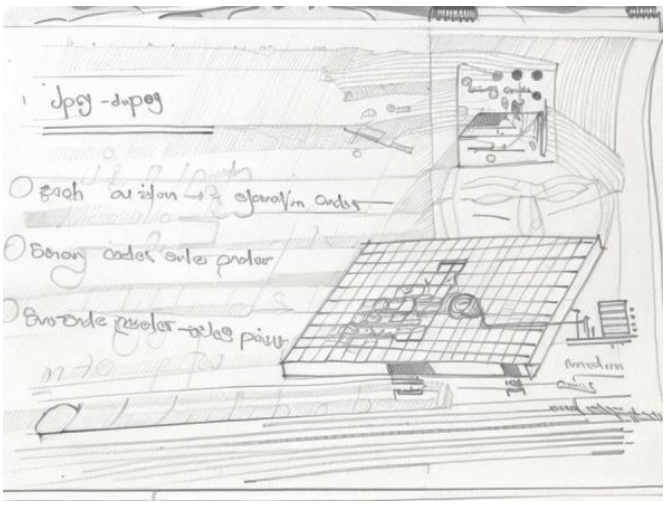


Figure 3-11

   - No barcode reader is needed; instead, a "Barcode reader + USB port" appears to be part of the design, possibly for programming or interfacing with the device.
   - The device can be implemented in 10 minutes.
   - The design is based on codes and elevations

3. **Squeeze-graph:**

An educational tool designed for visually impaired or blind individuals to understand and interact with graphical data.

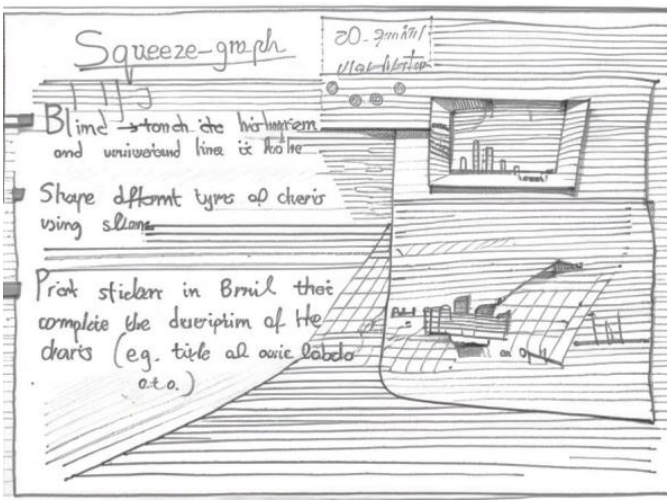
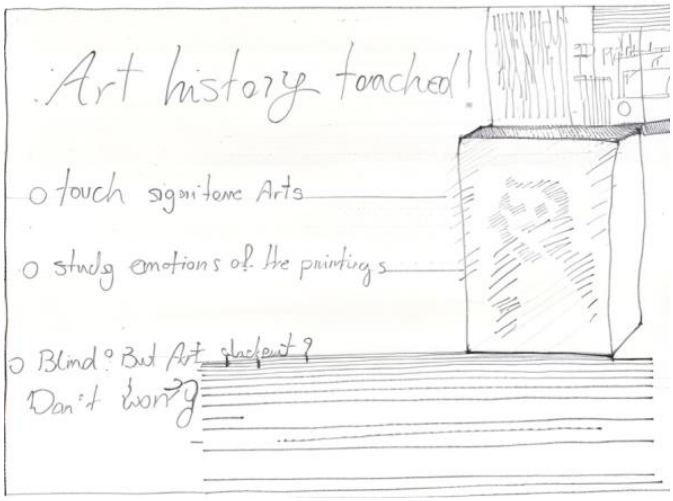


Figure 3-12

- It allows blind individuals to touch the histogram (or other types of charts) and understand its shape and layout.
- Different types of charts can be created using a substance referred to as "slime," which presumably provides a tactile way to represent data.
- Stickers printed in Braille can be added to complete the description of the charts, such as titles of axes, labels, etc.

4. **Art history touched:**

Another educational tool aimed at making art history accessible to blind or visually impaired students. The key points of this concept include:



- Providing the opportunity for students to physically touch signature artworks.
- Enabling the study of emotions conveyed by the paintings through tactile experience.
- Assuring blind art students that they can engage with art history despite their visual impairment.

In summary, the creative facilitated session helped reframe the initial problem and used creative techniques to generate innovative ideas for features and opportunities related to the context and assisting the visually impaired. The ideas align well with the values of enabling greater independence.

Idea Concepts

Idea Concept 1 Inclusive Infographic Narratives (IIN)

Inclusive Infographic Narratives (IIN) is an educational program designed to equip educators and content creators with the skills to make visual data accessible to all students, including those with vision impairment. The IIN program focuses on training key educational figures to articulate complex visual information in a clear and inclusive manner.

Target Audiences:

- Visually Impaired Students
- Lecturers and Educators
- Content Writers and Publishers
- Fellow Classmates
- Diversity & Inclusion Advocates

Training Objectives:

- **Comprehension**: Teach how to identify and articulate the core message of infographics.
- **Analysis**: Train to analyze and break down infographics into understandable segments.
- **Communication**: Develop skills to convey information using appropriate, jargon-free language.
- **Feedback**: Implement a system to collect feedback for continuous improvement of narratives.
- **Resource Provision**: Provide additional learning materials to aid the understanding of infographics.

Program Components:

- **Workshops**: Interactive sessions for lecturers and educators on effective infographic explanation techniques.
- **Online Tutorials**: A series of web-based tutorials for writers to learn how to create accessible content.

- **Feedback Mechanisms**: A platform for gathering and integrating student and peer feedback into content creation.
- **Accessibility Tools**: Guidance on incorporating alt text and accessible tags to accompany infographics.

Impact:

IIN aims to create an educational environment where visual information is no longer a barrier. By empowering educators and content creators, IIN ensures that all students can equally participate in learning activities, fostering a culture of inclusivity and diversity.

Next Steps:

1. Develop a comprehensive curriculum for the IIN program, addressing the specific needs of each target audience.
2. Pilot the program in select educational institutions to refine the approach based on real-world feedback.
3. Collaborate with accessibility software developers to integrate supportive technologies into the program.

Inclusive Infographic Narratives are more than just a training program—it's a movement towards an educational landscape where every student has access to knowledge. With IIN, we're not just teaching how to describe an infographic; we're opening doors to a world where education is universally accessible.

Idea Concept 2: Accessible Content Tags (ACT)

Accessible Content Tags (ACT) is a system designed to bridge the gap between visual content and accessibility for students with vision impairment. ACT utilizes QR codes and NFC tags linked to non-visual versions of infographics and educational materials, offering a gateway to a more inclusive learning experience.

How It Works:

Each infographic or visual material is paired with an ACT tag, which, when scanned by a smartphone or tablet, directs the student to an alternative version of the content. Alternative content formats include audio descriptions, tactile feedback, and other sensory representations, ensuring that the information is accessible to all students, regardless of visual ability. The system is compatible with popular accessibility apps like Envision, enhancing its functionality with features such as image recognition for detailed inquiries and interactive exploration of data.

Key Features:

- **Universal Design**: ACT tags are strategically placed alongside traditional infographics, ensuring that accessibility is an integrated part of the learning material, not an afterthought.
- **User-Centric Interaction**: Students can interact with the content in multiple ways—listening to audio descriptions, feeling haptic feedback, or using magnifiers—all facilitated by the ACT system.
- **Feedback-Driven Improvement**: The system is designed to evolve through user feedback, ensuring that the non-visual representations are continually refined to meet the needs of students with vision impairment effectively.

Implementation Strategy:

- **Pilot Program**: Launch a pilot in select educational institutions to integrate ACT tags with existing course materials and gather initial user feedback.
- **Collaboration with Accessibility Apps**: Work closely with Envision App to ensure seamless integration and functionality of the ACT system with educational context.

- **User Testing and Refinement**: Conduct regular testing sessions with students who have vision impairment to collect qualitative and quantitative data, using the insights to improve the system.

Impact:

By adopting the ACT system, educational institutions can significantly enhance the learning experience for students with vision impairment. The system not only provides equal access to information but also encourages independence and confidence in an academic setting.

Next Steps:

1. Develop a prototype of the ACT system, including a selection of ACT tags linked to various non-visual content formats.
2. Identify partner institutions and instructors willing to implement the pilot program.
3. Design a feedback mechanism to collect and analyze user experiences for ongoing development.

Accessible Content Tags represent a leap forward in educational inclusivity, offering students with vision impairment the autonomy to engage with visual materials on their own terms. The ACT system is a testament to the commitment to accessibility and the belief that every student deserves an equal opportunity to learn and succeed.

Idea Concept 3: AI-Enhanced Infographic Accessibility (AIIA)

AI-Enhanced Infographic Accessibility (AIIA) is a groundbreaking initiative to develop an AI-powered system that translates complex visual data into accessible formats for students with vision impairment. AIIA aims to harness the power of machine learning to automatically describe, interpret, and narrate the content of infographics, making them comprehensible without visual aid.

Key Features:

- **Data Collection**: Amass a diverse array of infographics from various fields to train the AI model.
- **Intelligent Labeling**: Annotate infographics with detailed descriptions to serve as learning benchmarks for AI.
- **Data Processing**: Utilize advanced image processing tools to prepare visuals for machine learning tasks.
- **Model Training**: Employ state-of-the-art computer vision and natural language processing models to interpret and narrate infographics.
- **Model Evaluation**: Rigorously test the AI model against a set of diverse infographics to validate performance.
- **User-Centric Deployment**: Integrate the trained AI model into a user-friendly interface, making it accessible via API.

Training Process:

- **Step-by-Step Training**: Sequentially train AI on recognizing and interpreting infographic elements and text.
- **Dual-Model Integration**: Combine visual and textual analysis for holistic understanding and narration.
- **Continuous Learning**: Regularly update the model with new data to enhance accuracy and expand knowledge base.
- **Performance Metrics**: Define clear metrics to quantify the AI's ability to accurately describe infographics.

Implementation:

- **Testing with End-Users**: Engage students with vision impairment to test AI-generated descriptions for clarity and usefulness.
- **Iterative Refinement**: Employ user feedback to fine-tune the AI model, enhancing its descriptive abilities.
- **Integration in Educational Tools**: Embed the AIIA system into existing educational platforms and tools.

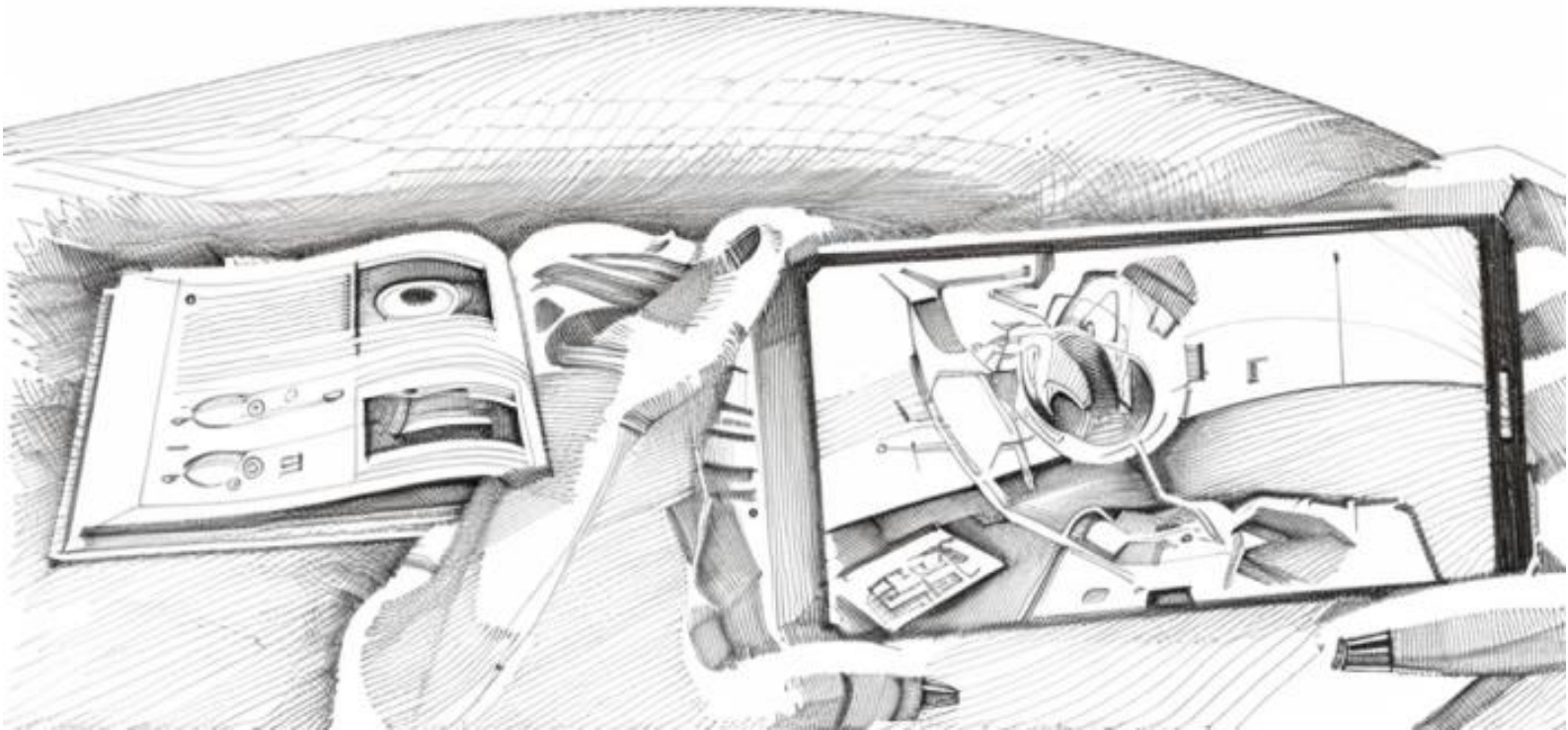
Impact:

AIIA promises to revolutionize the way visual information is delivered in educational settings, ensuring that students with vision impairment receive the same rich data insights as their sighted counterparts. Through AIIA, educators can make their teaching materials more inclusive without additional effort.

Next Steps:

1. Finalize the AIIA training and deployment protocol.
2. Form partnerships with educational institutions for pilot testing.
3. Seek continuous feedback for improvement from both educators and students .

AIIA is not just a technical solution; it's an **educational ally**, unlocking the full potential of infographics for all students. By bridging the visual gap with AI, AIIA stands at the forefront of inclusive education technology.



Evaluation

Evaluating the brainstormed ideas against the design implications and values checklist provided, we can synthesize the insights and potential directions for development as follows:

Accessibility and Inclusiveness:

- Audio Description and Narration Services excel in providing a universally accessible format, meeting the need for both accessibility and inclusiveness.
- Tactile Maps and Diagrams and Braille Translation Services address the personalization aspect, allowing for a customized experience that enhances safety and security.

Ease of Use and Customization:

- The Voice-Controlled Navigation System stands out for its intuitive design and potential for personalization, aligning with the ease of use and customization values.
- The Audio-Based Learning Platform offers a straightforward and user-friendly interface, essential for ease of use, and can be personalized to fit individual learning styles.

Safety and Affordability:

- Safety is inherently considered in services like the 3D Printing Technology for Scientific Models, where tactile interaction is prioritized.
- Affordability may be a concern with advanced technologies such as VR and AR learning, and thus, their cost-effectiveness must be evaluated against the value checklist.

Support and Flexibility:

- A service such as the Audio-Based Navigation App provides robust support and the flexibility to be used across various academic settings.
- The provision of Audio Descriptions for Images and Photos directly supports the comprehension of visual content, catering to the flexibility of learning methods.

Integration and Empowerment:

- Voice-Controlled Interactive Maps show a high level of integration with current mobile technology, empowering students to navigate independently.

- AI-Enhanced Infographic Accessibility (AIIA) can potentially empower students by providing immediate, AI-powered interpretations of visual data.

Collaboration and Growth:

- Inclusive Infographic Narratives (IIN) encourage collaboration by involving various stakeholders in the educational process and supporting the growth of students and educators alike.
- The use of AI to create accessible learning materials can foster a collaborative environment where students with vision impairment are actively included in all learning activities.

Considering Maslow's hierarchy of needs, these ideas also cater to the psychological aspects:

- **Security and Safety** are addressed by ensuring that services like tactile diagrams are reliable and easy to interpret.
- The need for **Belongingness and Love** is met through services that encourage social interactions, such as collaborative platforms for learning.
- **Esteem and Self-actualization** are promoted by tools that empower students to achieve independently and facilitate personal growth, such as the AI-Enhanced Infographic Accessibility (AIIA).

The ultimate goal is to ensure that each concept not only aligns with the design implications and values checklist but also effectively meets practical needs and enhances the educational experience of students with vision impairment. Through continuous iteration and user-centered design, these concepts can evolve into viable products and services that make a significant impact in the realm of inclusive education.

The conclusion advocates for a continued focus on inclusive design, ensuring educational tools and services go beyond mere functionality to meet students' fundamental human needs.

Conclusion:

The conclusion of this chapter synthesizes insights and directs future steps:

- **Idea Generation**: The process yielded over 100 diverse solutions, reflecting the ambition to address the multifaceted challenges faced by students with vision impairment.
- **User-Centric Design**: Solutions were scrutinized against a set of design implications, ensuring they align with user values like accessibility and independence, confirming their potential effectiveness in enhancing the educational experience.
- **Values Alignment**: The design implications were mapped to psychological needs, cementing the importance of addressing emotional well-being alongside functional requirements.

Key Outcomes:

- Innovations such as Accessible Content Tags (ACT) and AI-Enhanced Infographic Accessibility (AIIA) emerged as transformative, promising to redefine how educational content is accessed.
- Flexibility and adaptability were identified as crucial, allowing for a tailored educational experience across various learning environments.
- A commitment to iterative design was solidified, emphasizing the necessity for prototypes to evolve through feedback from the target user group.

Directions for Iteration

- The exploration highlighted the importance of multi-modal learning experiences, integrating senses beyond sight and sound for a richer educational journey.
- AI's role as a transformative agent in education was underscored, with its capacity to personalize learning and enhance accessibility.

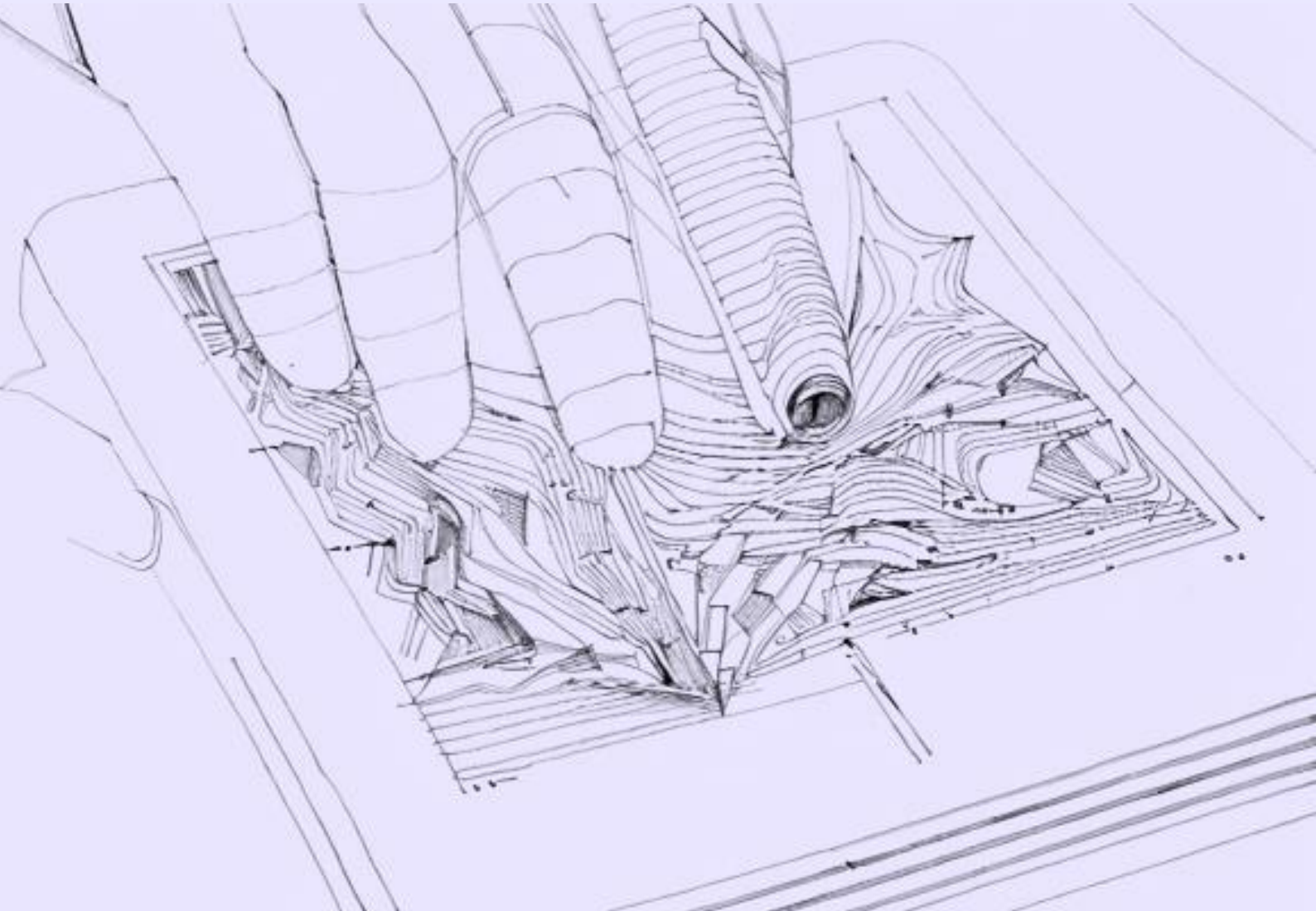
3.3 Iteration

Introduction:

This chapter delves into the iterative design process that shaped the concept “Envision for Education” platform, tailored to enhance learning for students with vision impairment. The journey began with comprehensive user research, employing interviews and personas to capture a spectrum of needs and expectations.

From initial concepts to interactive prototypes. Each scenario shed light on the practicalities of use and user satisfaction, refining the service blueprint and ensuring a seamless user experience.

User journey scenarios spotlighted the platform's role in not just aiding individual learning, but also in nurturing an inclusive academic community. The closing section of the chapter connects the dots between research findings and the consequent design choices, describing how informed decisions have paved the way for an accessible and empowering educational tool.



Method:

This stage is characterized by a cyclic process of design, testing, feedback, and redesign, ensuring that the final product is both functional and user-friendly for students with vision impairment.

Concept Development:

- **Low-fidelity prototyping**: which are basic versions of the product that focus on functionality and user interaction rather than detailed aesthetics. These prototypes are crucial for understanding the core features and testing the viability of the design concepts.
- **Scenario Design:** Use cases are developed to represent the various situations in which the platform will be used. These scenarios help anticipate user behavior and identify potential challenges within the platform's design.

Concept Evaluation:

- **Prototype Usability Testing:** Involves a small group of participants (5 for optimal feedback, blindfolded) who interact with the prototype. Their behavior and feedback provide valuable insights into the intuitiveness of the design and identify areas for improvement.
- **Scenario Evaluation:** Conducted with 2 visually impaired individuals to validate previously attained results by blindfolding, this cognitive walkthrough is a structured approach to evaluating the prototype's usability. It focuses on how well the platform supports users in achieving their goals within specific scenarios, ensuring that the user journey is logical and seamless.
- **PMI:** decision-making tool that stands for "Plus, Minus, Interesting" which guides to evaluate an idea by considering its positives, negatives, and points that are neither but still intriguing, was conducted from the aforementioned Prototype Testing and Scenario evaluations. To provide a balanced view and comprehensive thinking about potential implications.

The iterative process not only enhances the usability of the concepts, but also ensures that it truly resonates with the needs and values of the students it's designed to support.

Concept Development

Integrating the previous chapter's innovative concepts into the scenario design, a comprehensive user experience that embodies the principles of accessibility and inclusivity was crafted. Some ideas—Neuro Link brain connectors, Upsy-dupsy, Squeeze-graph, and Art history touched—have been developed into a coherent scenario that addresses real-world challenges faced by visually impaired students like Nina- the persona.

Envision Ally for Students is the culmination of these ideas, transformed into a tangible service that empowers students to overcome the barrier of inaccessible infographics. This service draws upon the initial concept of connecting to the brain's neurons, as seen with the Neuro Link brain connector, to create a platform where information transcends visual limitations. It also borrows the tactile innovation from the Squeeze-graph and Art history touched concepts, providing a sensory-rich interpretation of data and artworks.

The scenario unfolds as Nina navigates her educational environment with newfound ease, thanks to the forward-thinking solutions that emerged from a creative and empathetic design process. The focus on user behavior, potential challenges, and the ultimate goal of equal educational opportunity has shaped a scenario where Sarah, supported by her classmates and the ingenuity of AI, engages with her curriculum on an equal footing.

User Scenario

Meet Nina, a visually impaired student who is studying at a university. Nina loves to learn and is passionate about her studies, but she often faces challenges in understanding the infographics in her textbooks. Sarah is frustrated because she knows that infographics are a crucial part of her curriculum, and she doesn't want to miss out on important information.

One day, Nina 's classmate, Ali, tells her about a new service called **Envision Ally for students**. Ali explains that this service is designed to help visually impaired students like Nina understand infographics in their textbooks. He encourages Nina to sign up for the service, and Nina is intrigued.

Nina decides to give it a try and signs up for Envision Ally for students. She is happy to discover that the service works by allowing her fellow classmates to sign up as allies. **These allies can**

explain the graphs and charts in their own words, and AI cumulatively arranges the best explanation, which is then assigned through the app to the graph.

Nina's classmates start signing up as allies, and they provide detailed explanations of the infographics in her textbooks. The explanations are informative and easy to understand, and Nina is thrilled to finally be able to comprehend the infographics.

The best part of the service is that students can **link the explanation through different mediums to the textbook**. Nina can choose from **alt text** or **audio descriptions** if the book is digital, or **nfc tags** or **accessible QR codes** if the book is in paper. Nina is happy that she can now access the information she needs, and she feels **empowered** to keep learning and exploring new ideas.

Thanks to Envision Ally for students, Sarah can finally learn with **confidence**, knowing that she has the **support** she needs to succeed in her studies.

Concept Evaluation Plan

Here's an evaluation plan for the three concepts of infographic **un**visualization, relating to the scenario involving Nina, the visually impaired student:

Table 3-2

Concept	Test method	Target user
Digital infograph unvisualized	black screen + haptic feedback (touchpoints)	anyone
	black screen + sound feedback (trend drop, rise, steady)	anyone
	black screen + voiceover description	anyone
Analog (print) infograph unvisualized	3D layer print on chart lines + describe what is understood	low vision / blindfold
Infograph typology Rate complexity of different types	visual example rating survey	low vision
	3D layer print on chart lines + describe what is understood	low vision / blindfold

Based on the image provided, here's an evaluation plan for the three concepts of infographic unvisualization, relating them to the scenario involving Sarah, the visually impaired student:

Concept Test 1: Infographic Typology

To tailor educational tools for students with vision impairment, a thorough investigation into the most common data visualizations used by these students was essential. This involved examining

various types of data visualizations across different platforms and educational fields to determine their relevance and application.

Development:

- Rate Complexity: This concept involves developing a system to rate the complexity of different types of infographics, which may be used to guide the design process to ensure inclusivity.
- 3D Layer Print Testing: Similar to the analog concept, 3D printing would be used to create tactile versions of various infographic types for testing.

Evaluation:

- Complexity Rating Feedback: Users with low vision or those who are blindfolded would provide feedback on the rated complexity after interacting with the 3D layer prints.
- Description and Understanding: After interacting with the 3D prints, users would describe what they understand from each type, which would be used to evaluate the accuracy of the complexity ratings and the effectiveness of the typology in conveying the intended information.

In the context of the scenario with Nina, these evaluation methods would directly contribute to refining the tools and services offered by Envision Ally. For example, the feedback from low vision users on the analog concept could help in tailoring the tactile infographics to better suit Nina's needs, while the digital concept's evaluation could enhance the platform's features for interpreting infographics for all students. Finally, the typology concept would guide educators and developers in creating materials that are accessible to students like Sarah, ensuring they have equal access to educational content.

Infographic Typology Results

Research on Data Visualization Usage:

- A review was conducted on popular data visualization tools such as **Qualtrics**, **Microsoft Power BI**, and Tableau, as well as educational resources like the "Learning Infographic Design" course by Amy Balliett.

- This led to a detailed categorization of infographics, revealing three primary types of visual data: Navigation & Orientation, Infographics, and Multimedia.

Prioritizing Based on User Frustration:

- To determine which data visualization type warranted primary focus, visually impaired participants were engaged in storytelling sessions. They were asked to recount their experiences with charts and graphs in their studies, highlighting particularly challenging or frustrating instances.
- The data visualization type associated with the most user frustration was given priority in the design process, ensuring that the proposed solutions would address the most pressing issues faced by the students.

By combining **theoretical research** with **user-led insights**, a clear direction was established for the design initiative, ensuring that the resulting educational tools would be both relevant and user-centric, alleviating key pain points for students with vision impairment.

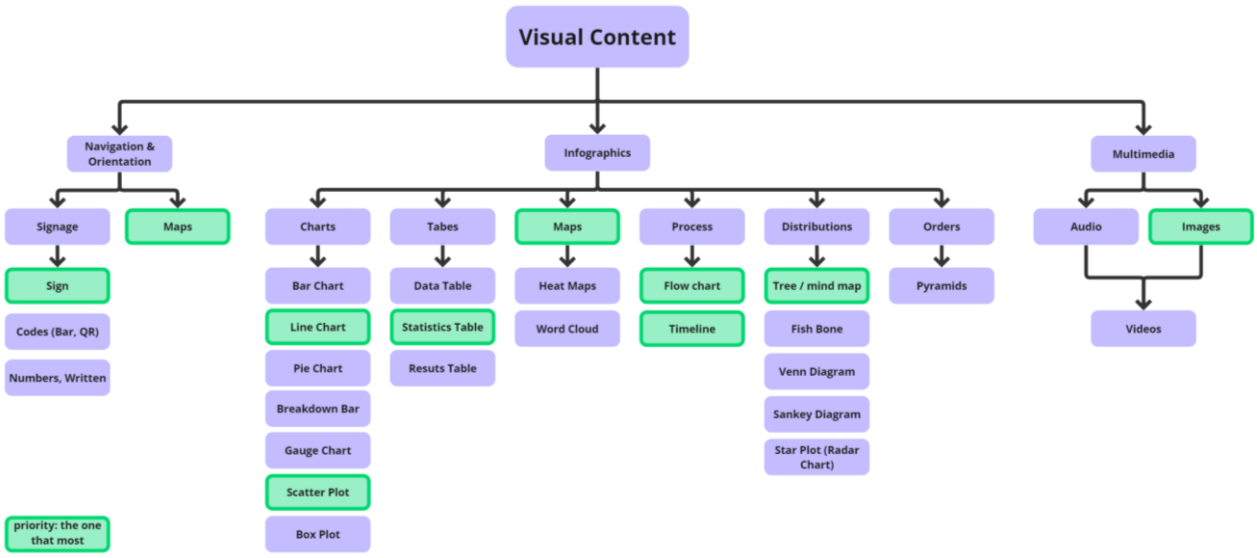


Figure 3-13

The flowchart of "**Visual Content**," categorizing different types of visual information used in content creation and presentation. It is divided into three main categories: **Navigation & Orientation, Infographics, and Multimedia.**

Under Navigation & Orientation, there are subcategories such as Signage, which includes signs, codes (like bar or QR codes), and written numbers. Maps are also a part of this category but are not further subdivided in the image.

Infographics are divided into several types of visual representations including Charts (with types like Bar, Line, Pie, Breakdown Bar, Gauge, Scatter Plot, and Box Plot), Tables (Data, Statistics, Results), Maps again (possibly thematic or geographic), and Process representations like Flow Charts and Timelines.

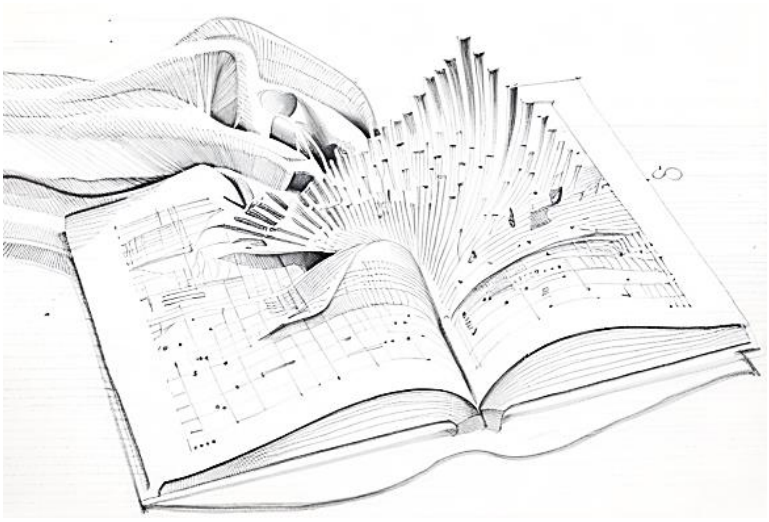
The Multimedia category branches out into Audio, Images, and Videos, indicating different types of media content.

A note highlights "priority: the one that most," which may suggest a focus on the most effective type of visual content for the particular context of this project. This flowchart is a tool for planning and organizing content, ensuring that the chosen form of visual aid aligns with the intended message and audience needs.

Concept Test 2: Analog Infographic Unvisualization

Development:

- 3D Layer Print on Chart Lines: The analog infographic would be developed by creating a tactile representation through 3D printing. Lines and shapes from infographics would be printed in layers that can be felt by touch.
- Visual Example Rating Survey: This aspect would involve creating a survey with visual examples rated for complexity. The results would help tailor the analog infographics to the specific needs of users with low vision.



Evaluation:

- Test with Low Vision/Blindfolded Users: The effectiveness of the analog infographics would be evaluated by asking users with low vision or blindfolded users to touch the 3D printed lines and describe what they understand.
- Survey Feedback: Low vision users would be given a survey to rate the effectiveness of different visual examples, providing feedback on how well they can understand and interpret the information through touch.

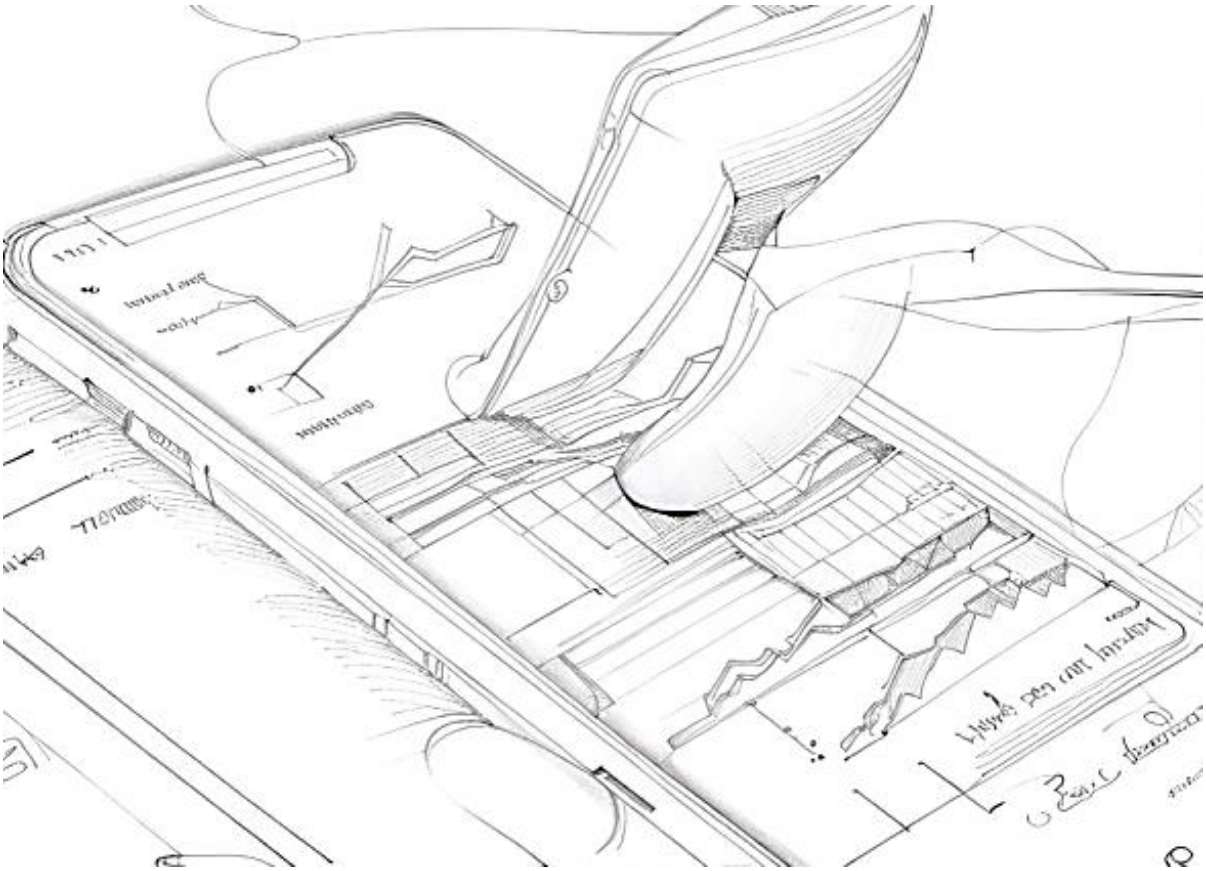
Concept Test 3: Digital Infographic Unvisualization

Development:

- Haptic Feedback: Digital infographics would be unvisualized by incorporating haptic feedback to convey information through touch.
- Sound Feedback: Sound cues would be used to represent trends such as rising, dropping, or steady data points.
- Voiceover Description: Voiceover technology would describe the content and context of the infographics for a comprehensive understanding without visual input.

Evaluation:

- User Testing with Various Feedback Methods: Evaluation would involve user testing with the black screen while utilizing the different feedback methods (haptic, sound, and voiceover) to determine which is most effective for 'anyone', including those with full vision as well as those who are visually impaired.
- Comparison of Comprehension: The understanding of the infographic content with each method would be compared to evaluate which provides the most clarity and user-friendly experience for 'anyone'.



Concepts Scenario-based Evaluation

Concepts evaluated using the PMI (Plus, Minus, Interesting) method. Based on the text in the image, here are insights and conclusions drawn from the evaluations:

- **Plus Points:** The use of AI is seen as a positive advancement that makes tasks easier and requires less effort for learning. This indicates a general approval of integrating technology to simplify and enhance the educational process for students with vision impairment.
- **Minus Points:**
    - There is criticism that sound and vibration feedback does not effectively explain the content of the graph. This suggests that while the concept of non-visual feedback is innovative, its current implementation may not convey the necessary information adequately.
    - Interactive feedback such as increasing sound and vibration is seen as potentially fun but also distracting from the learning process. This feedback points to a need for a careful balance between engagement and educational value.
- **Interesting Points:** The notion that interactive feedback can be both fun and distracting is noted as an interesting point. This duality captures the attention and could suggest that while such features are engaging, they need to be designed in a way that does not detract from the educational goals.

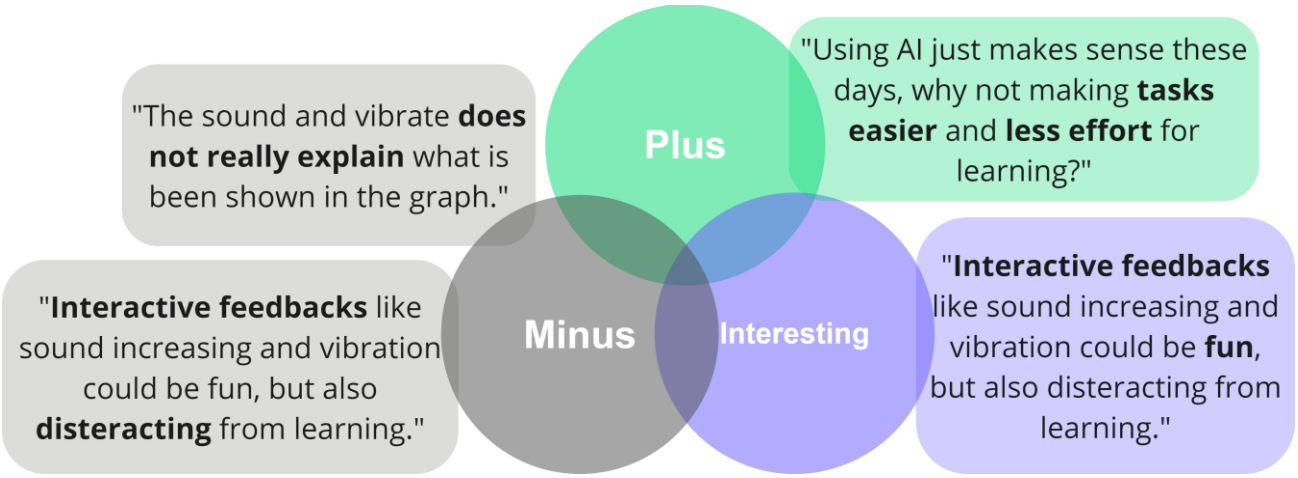


Figure 3-14

Insights and Conclusions

Based on the PMI evaluation:

1. **AI Integration**: There is a clear interest in leveraging AI to support learning. However, the implementation needs to be purposeful, with AI applications that directly contribute to understanding rather than just simplifying interactions.
2. **Effectiveness of Sensory Feedback**: The feedback mechanisms, although innovative, must be refined to ensure they are informative and not just novel. They should add value to the learning experience by enhancing comprehension, not just providing sensory stimulation.
3. **Balance Between Engagement and Education**: The fun aspect of interactive feedback is recognized but must be managed to avoid becoming a distraction. Future iterations should focus on how these elements can be utilized to support learning outcomes.
4. **Further Development**: There is a need for further development to align the sensory feedback more closely with the educational content. This could involve more nuanced sound design or haptic patterns that more precisely map to the data being represented.
5. **User-Centric Design**: The feedback emphasizes the importance of user-centric design in educational tools for visually impaired students. The tools should be designed with the users' educational needs as the primary focus, ensuring that they are both engaging and effective in conveying information.

Service Concept

Eduvision - Envision for Education

“An inclusive and accessible educational environment for all students.”

By combining the evaluated service concepts into a single unified platform **Eduvision**, this service integrates the features of **Envision Seamless Image Segmentation** and **Envision Ally**. This service fosters an inclusive educational environment by leveraging AI for content processing and establishing a community of learners and allies for collaborative learning. Through multimodal access, personalized experiences, and community engagement, Envision Educator empowers visually impaired students in their educational journey.

Figure 3-15

The Figure illustrates the alignment of the Envision for Education service with Maslow's hierarchy of needs, showcasing how the platform is designed to cater to the various levels of user requirements from physiological needs all the way to self-actualization. Here's how the service concept ties in with the design implications and values previously outlined:

- Physiological Needs: By incorporating AI for image segmentation, Envision for Education ensures that basic access to educational content is met, addressing the fundamental need for information consumption which is as essential as any other physiological need in today's information age.

- Safety Needs: The platform promotes safety and security by providing a reliable and consistent learning environment, where students with vision impairment can depend on the same level of access as their sighted peers.
- Love and Belonging: Through the community features of Envision Educator, students are offered a sense of belonging and connection, fulfilling the social aspect of the hierarchy.
- Esteem Needs: By facilitating independence and providing tools for students to achieve academic success on their own terms, Envision for Education empowers students, thereby fostering self-esteem and respect.
- Self-actualization: Ultimately, the service concept enables students to reach their full potential by removing barriers to education and allowing for personal growth and self-fulfillment.

The service concept of Envision for Education, symbolized by the combined service of Envision Educator, realizes an inclusive and accessible educational environment. It integrates the values of independence and inclusion, crucial for a holistic educational experience, and reflects these in every layer of the service delivery. By fulfilling the psychological needs through design implications, Envision for Education encapsulates the essence of an inclusive educational platform that not only supports academic pursuits but also nurtures the overall growth and development of students with vision impairment.

Eduvision Seamless Service Blueprint

Physical Evidence:

- Unified Accessible Web Application: - Design an intuitive, clean user interface (UI) focusing on accessibility. - Ensure high contrast and large fonts for readability. - Integrate a feature for users to adjust the color scheme based on visual preferences.
- Textbooks, Infographics, and Educational Materials: - Implement a feature to upload digital materials. - Design the app to work with NFC tags and QR codes for physical materials.
- Audio Descriptions and Alt Texts: - Develop an AI-based text-to-speech system to convert text into audio. - Provide alt text for all visual elements.
- Tactile Controls and Screen Reader Compatibility: - Ensure compatibility with popular screen readers. - Implement feedback systems like vibrations for tactile interactions.

Customer Actions:

- Registration and Login: - Create a simple registration form with accessibility in mind. - Implement secure authentication protocols.
- Select or Upload Content: - Design a user-friendly file selection/upload interface. - Use simple drag-and-drop functionality for file uploads.
- Choose Explanation Medium: - Implement a simple drop-down or selection interface to choose a preferred medium.
- Access Content: - Design a responsive content viewing section, with support for chosen mediums (e.g. audio, alt text).
- Provide or Receive Help: - Implement a community feature where users can submit and receive content explanations.

Frontstage Interactions:

- Accessibility Support: - Embed live chat support and create a FAQ section for immediate help. - Include contact information for additional support.
- AI Feedback: - Utilize AI algorithms for image analysis and content sorting. - Provide real-time audio feedback for analyzed content.
- Tutorial and Guidance: - Develop video and text tutorials for new users. - Include audio guidance for visually impaired users.
- Interactive Community: - Design a community forum or message board. - Allow for direct messaging between users for collaboration.

Backstage Interactions:

- Content Processing: - Implement AI models for image processing and content analysis.
- Explanation Analysis and Assignment: - Integrate AI algorithms to match and assign explanations to content.
- Conversion to Chosen Medium: - Implement conversion protocols to change content into the selected medium (audio, alt text, etc.).

Support Processes:

- Continuous AI Model Training and Maintenance: - Regularly update the AI models with new data. - Monitor the AI systems for errors and performance.

- Accessibility Testing and Improvement: - Regularly conduct accessibility tests. - Collect user feedback for continuous improvement.
- Data Storage, Security, and Compliance: - Ensure that data is stored securely and is compliant with privacy regulations.
- Community Moderation: - Develop a moderation system to verify and moderate content from allies.

Service Delivery:

- Unified Platform: - Ensure that the platform effectively integrates both Envision Seamless Image Segmentation and Envision Ally functionalities seamlessly.
- Multimodal Access: - Implement features that allow content to be accessed in multiple formats (audio, text, etc).
- Community Engagement: - Encourage community involvement through gamification, rewards, or recognition systems.

Service Outcomes:

- Empowered Learning: - Regularly evaluate how the service is enhancing learning experiences.
- Inclusive Education: - Gather feedback from diverse users to understand inclusivity.
- Personalized Learning Experience: - Add customization options for users.
- Building Community: - Evaluate and track community growth and engagement.

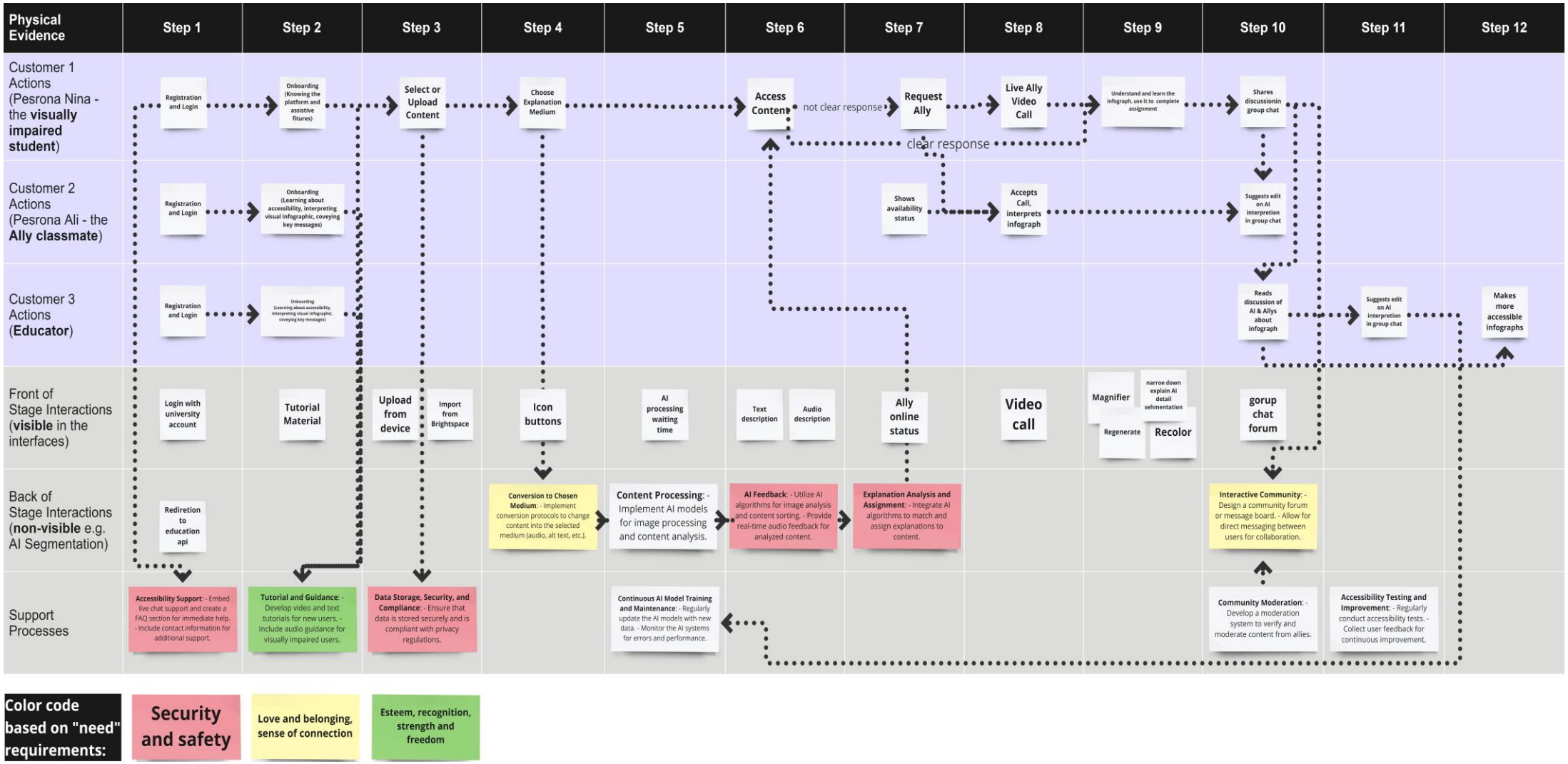


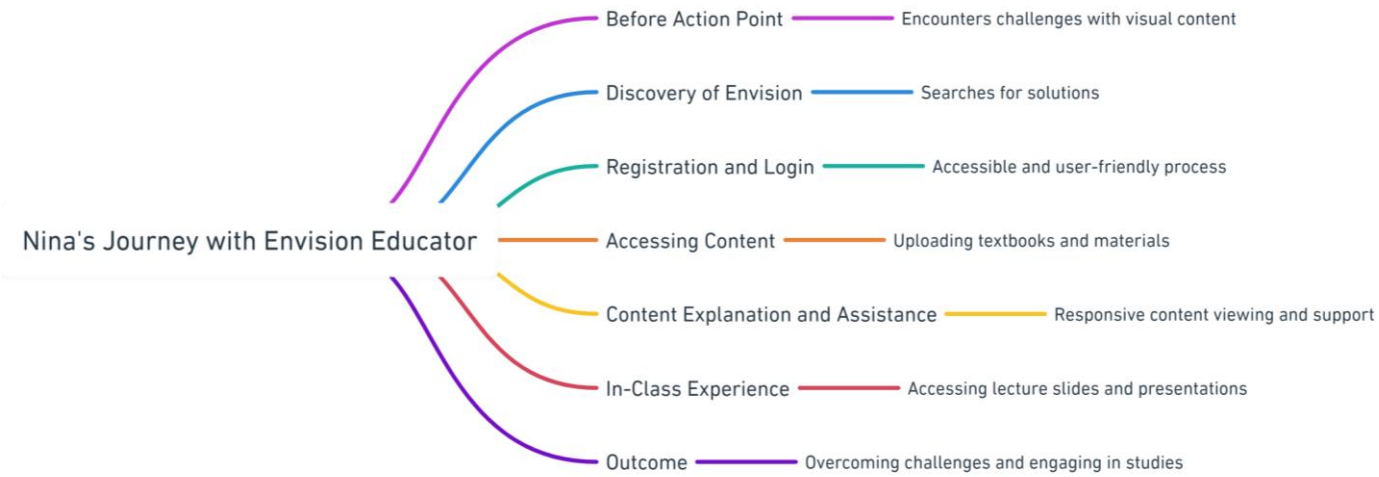
Figure 3-16 Service Blueprint

User Journeys for Envision Education

Nina (Visually Impaired Social Sciences Student):

1. **Before Action Point**: Nina, a visually impaired student studying social sciences in North Europe, encounters challenges in accessing visual educational content. She struggles with understanding infographics and charts, which are essential in her coursework. Nina feels anxious and frustrated as she tries to navigate online platforms and digital books without proper accessibility features.
2. **Discovery of Envision**: Nina becomes aware of Envision through a search for solutions that can assist visually impaired students in accessing visual content. She comes across an advertisement on her university campus promoting Envision's inclusive and accessible educational environment. Intrigued by the possibilities, she decides to explore the Envision Educator platform.
3. **Registration and Login**: Nina visits the Envision Educator website and registers for an account. The registration process is designed to be accessible and user-friendly, with considerations for Nina's low vision. She securely logs in to her account, gaining access to the platform's features.
4. **Accessing Content**: Nina begins by uploading her digital textbooks and course materials to the platform. Envision Educator's intuitive file selection interface allows her to easily choose and upload the required content. She selects her preferred medium for explanations, such as audio descriptions or alt text.
5. **Content Explanation and Assistance**: With her content uploaded, Nina accesses the materials through Envision Educator's responsive content viewing section. The platform provides explanations in her chosen medium, ensuring she can understand the visual elements effectively. If she needs further assistance, Nina can seek help from the Envision community, submitting content for explanation or receiving support from other users.
6. **In-Class Experience**: In the classroom, Nina relies on Envision Educator to access lecture slides and visual presentations. The platform converts the visuals into her preferred medium, enabling her to follow along with the class. With Envision Educator's support, Nina feels more confident and engaged in her studies.
7. **Outcome**: Nina's use of Envision Educator enables her to overcome the challenges posed by visual content. She can effectively read academic literature, participate in exams, and

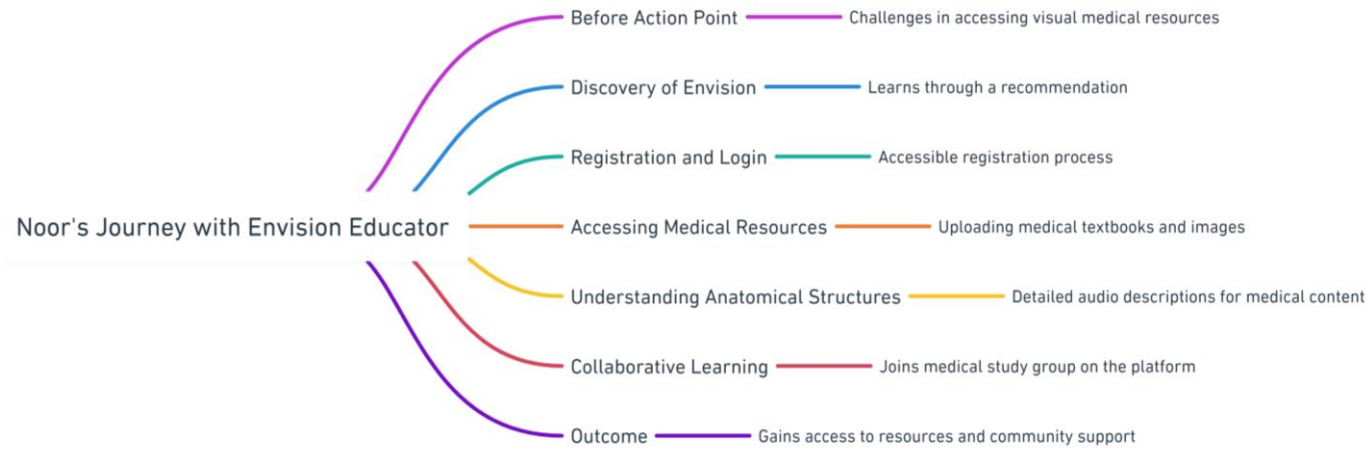
comprehend lecture materials. By accessing visual information in a non-visualized format, Nina experiences a more inclusive and empowering educational environment.



Noor (Visually Impaired Medical Student):

1. **Before Action Point**: Noor, a visually impaired student pursuing a degree in medicine, encounters challenges in accessing visual medical resources and diagrams. She struggles with understanding anatomical structures, medical images, and diagrams during her studies. Noor feels overwhelmed and concerned about how these barriers might affect her ability to succeed in her medical education.
2. **Discovery of Envision**: Noor learns about Envision through a recommendation from a fellow medical student who had previously faced similar challenges. Her friend shares how Envision's accessible tools and resources helped them overcome barriers in their medical studies. Intrigued by the potential benefits, Noor decides to explore the Envision Educator platform.
3. **Registration and Login**: Noor visits the Envision Educator website and completes the registration process to create her account. The registration form is designed with accessibility in mind, ensuring a smooth and inclusive experience for visually impaired users. After logging in, she gains access to the platform's features.
4. **Accessing Medical Resources**: Noor uploads her medical textbooks, lecture notes, and medical images onto the Envision Educator platform. The user-friendly file selection interface makes it easy for her to choose and upload the required materials. She selects audio descriptions and alt text as her preferred mediums for explanations.

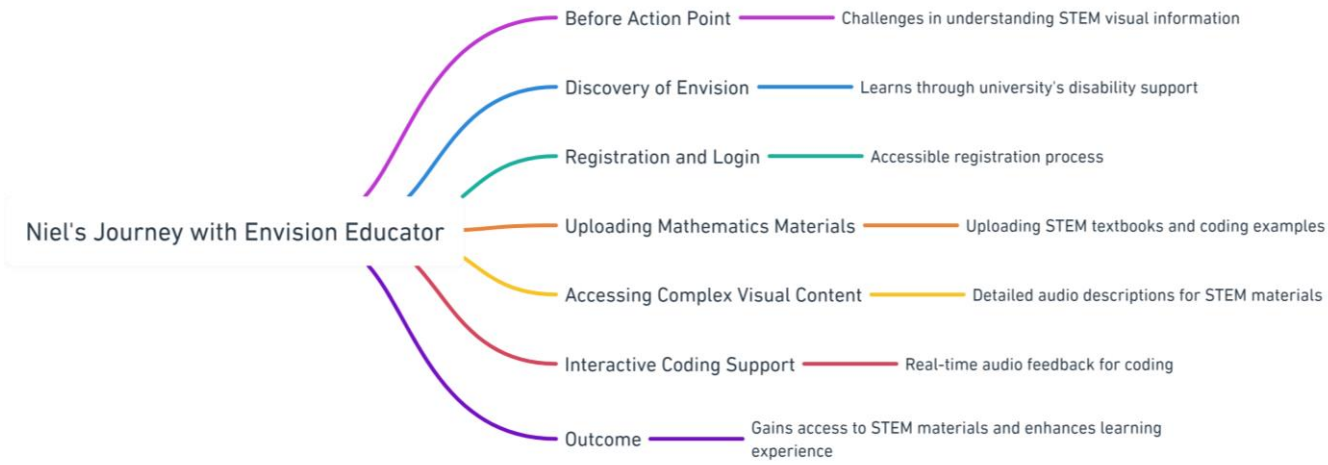
5. **Understanding Anatomical Structures**: Using Envision Educator's responsive content viewing section, Noor can access her medical resources. The platform provides detailed audio descriptions for anatomical structures, medical images, and diagrams, allowing her to comprehend the visual elements effectively. This enables Noor to studyand visualize complex medical concepts, improving her understanding and knowledge retention.
6. **Collaborative Learning**: Noor discovers the community engagement features of Envision Educator. She joins a medical study group within the platform, where she can connect with fellow visually impaired medical students and allies. They share resources, discuss challenging topics, and support each other in their educational journey. This collaborative learning environment enhances Noor's sense of belonging and provides a valuable support network.
7. **Outcome**: Through Envision Educator, Noor gains access to medical resources in an accessible format tailored to her needs. The platform's audio descriptions and alt text enable her to understand and visualize anatomical structures, medical images, and diagrams effectively. Additionally, the community engagement features foster a sense of connection and support among visually impaired medical students, creating a more inclusive and collaborative learning environment.



Niel (Visually Impaired STEM Student):

1. **Before Action Point**: Niel, a visually impaired student majoring in computer science, faces significant challenges in understanding complex visual information related to STEM subjects. He struggles with comprehending mathematical equations, data visualizations, and coding examples. Niel feels overwhelmed and frustrated as he tries to navigate his coursework without accessible tools.

2. **Discovery of Envision**: Niel learns about Envision through a recommendation from his university's disability support services. They inform him about Envision's advanced features tailored for visually impaired STEM students. Intrigued by the possibilities, he decides to explore the Envision Educator platform.
3. **Registration and Login**: Niel visits the Envision Educator website and registers for an account. The registration process considers the accessibility needs of visually impaired users, ensuring a seamless experience. After securely logging in, he gains access to the platform's features.
4. **Uploading Mathematics Materials**: Niel uploads his STEM textbooks, lecture slides, and coding examples onto the Envision Educator platform. The intuitive file selection interface makes it easy for him to choose and upload the required materials. He selects audio descriptions as his preferred medium for explanations.
5. **Accessing Complex Visual Content**: Using Envision Educator's responsive content viewing section, Niel can access his STEM materials. The platform provides detailed audio descriptions for mathematical equations, data visualizations, and code snippets, enabling him to comprehend the visual elements effectively. This empowers Niel to fully engage with his STEM coursework.
6. **Interactive Coding Support (live image segmentation)**: When working on coding assignments or projects, Niel leverages Envision Educator's interactive coding support feature. The platform provides real-time audio feedback, identifying syntax errors and suggesting corrections. This assistance streamlines Niel's coding process and helps him develop his programming skills.
7. **Outcome**: Through Envision Educator, Niel gains access to STEM materials in a non-visualized format tailored to his needs. He can now understand complex visual information related to mathematics, data analysis, and coding. Envision Educator enhances Niel's learning experience and fosters his success as a visually impaired STEM student.



Ally (Non-Visually Impaired Classmate):

1. **Feeling the Need to Help**: As an ally to visually impaired students, the ally notices the struggles faced by their visually impaired classmate, Nina. The ally feels a strong desire to support Nina in her academic journey and ensure her inclusion in the classroom.
2. **Discovery of Envision**: The ally learns about Envision through an advertisement on campus, which highlights the opportunity to assist visually impaired students. Intrigued by the chance to make a difference, the ally decides to explore Envision's services.
3. **Registration and Login**: The ally visits the Envision Educator website and registers as an ally, creating an account. The registration process is straightforward and emphasizes the ally's commitment to supporting visually impaired students. After logging in, the ally gains access to the Envision Educator platform.
4. **Understanding the Platform**: The ally familiarizes themselves with the features of Envision Educator, learning how they can provide assistance to visually impaired students. They explore the platform's community features, including the **how to help instructions** the ability to receive content submissions from visually impaired students and provide explanations and support.
5. **Assisting the Visually Impaired Classmate**: When Nina, the visually impaired classmate, requires assistance, the ally offers their support through Envision Educator through text (that will be read out for Nina by the app), live video call, or audio. They engage in collaborative learning by explaining visual elements, describing images, and providing additional context for the content. The ally's contributions enhance Nina's understanding and foster a sense of inclusion in the classroom.

6. **Outcome**: Through their involvement with Envision Educator, the ally experiences the rewards of supporting visually impaired students. They witness the positive impact of their assistance on Nina's educational experience, fostering a stronger sense of community and inclusion within the classroom. The ally's efforts contribute to creating a more inclusive learning environment for all students.

Conclusion:

Eduvision - Envision for Education breaks down barriers and cultivates a culture of inclusivity, where differences are celebrated, and everyone's contributions are valued. By working together, students can collectively overcome challenges, expand their understanding, and build lasting connections. This is a step towards creating a learning environment where all students, regardless of their abilities, **feel a sense of inclusion**, empowerment, and success.

3.4 Implementation

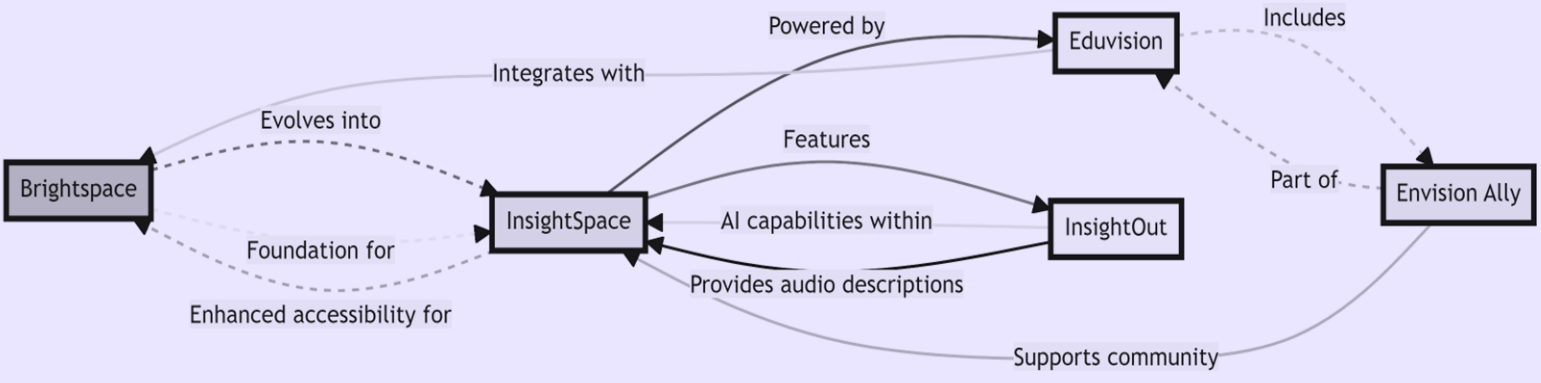
Introduction:

The implementation chapter marks the transition from design to reality, where the final higher-fidelity prototype of Envision for Education takes shape, on the track for integration into the educational platforms, in this case, **transition of "Brightspace" to "InisightSpace" with the "InsightOut" AI-powered feature of Eduvision integrated to the day-to-day study platform for inclusive education.**

This phase focuses on the meticulous construction of a service blueprint for developers, laying out the intricate web of functionalities and interactions that underpin the platform.

A comprehensive user journey map is also prepared, offering stakeholders a window into the envisioned experiences of end-users. This includes detailed screens and interfaces designed for intuitive navigation and engagement. The chapter further explores the development of the AI component and its associated plugins, complete with the coding framework essential for seamless operation.

To ensure the platform's efficacy, scenario evaluations are conducted, stress-testing the system across various educational contexts to affirm its readiness to enhance learning for students with vision impairment. Through this chapter, the narrative unfolds the careful orchestration of technical and human elements required to bring a visionary educational tool to fruition.



Method:

The Implementation chapter is the stage where concepts are brought into existence, transforming ideas into tangible solutions. Here, the design efforts converge into a practical form, ready to be deployed within educational environments such as Brightspace platform.

- **Service Blueprint Development**: Crafting a comprehensive blueprint that serves as a detailed guide for developers, encapsulating the intended functionality, interactions, and user flows.
- **User Journey**: Creating a narrative that outlines the user's experience, providing stakeholders with a clear representation of the user's interactions from start to finish.
- **Interface and Screen Design**: Designing the user interfaces and screens **based on the previously defined user journey, using Figma,** focus**ing** on intuitive **and accessible** use**.**
- **AI Integration**: Developing and coding the AI component, 'InsightOut,' which integrates into the 'InsightSpace' platform, bringing advanced, AI-powered **feature of describing charts and graphs** to support inclusive education.
- **Scenario Evaluation**: testing the system through scenario evaluations to validate its performance and ensure it meets the varied needs of students with vision impairment.

InsightSpace

Concept Description

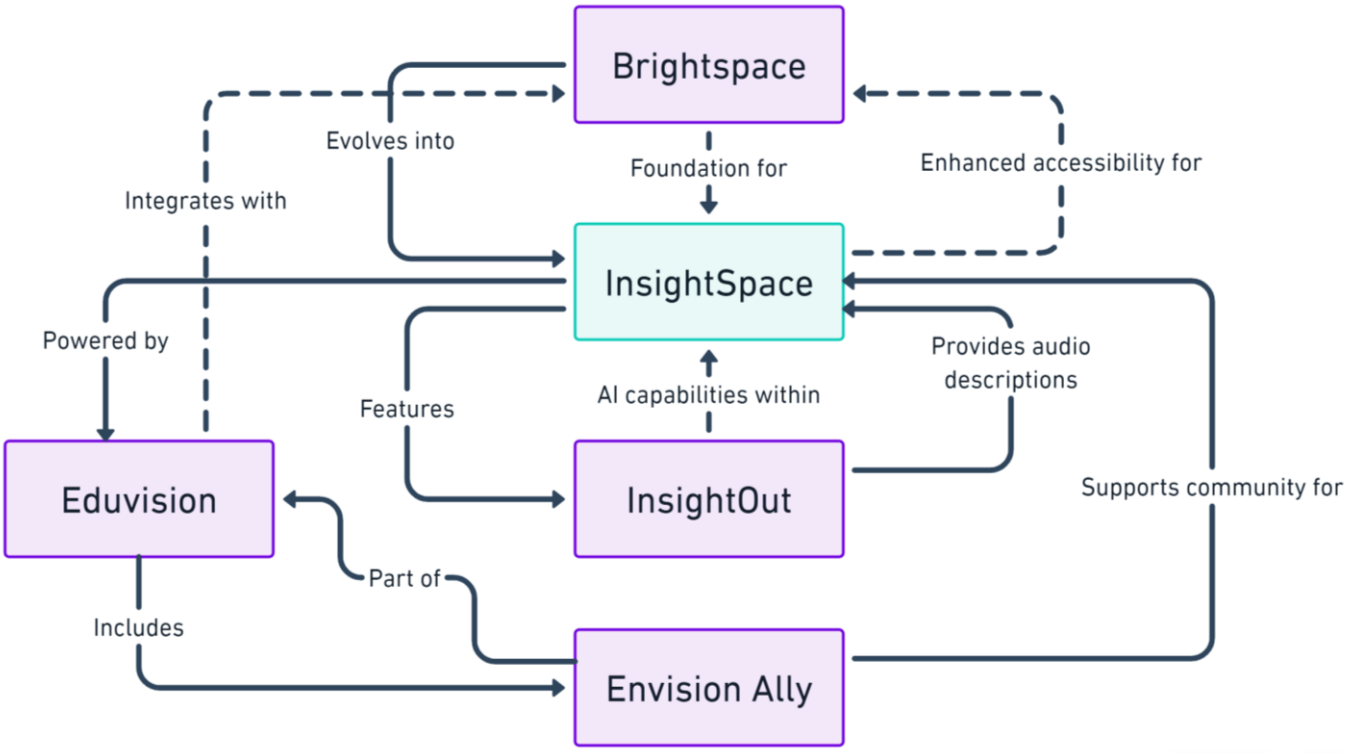
The transition from **Brightspace** to **InsightSpace**, fortified with the **Eduvision** technology, represents a significant leap forward in creating an accessible and inclusive learning environment. InsightSpace, armed with the "**InsightOut**" AI plugin, exemplifies the practical application of research insights and design implications outlined in the "Exploration" and "Design Implications" chapters.

Let's clarify the connections and functionalities between Brightspace, InsightSpace, Eduvision, Envision Ally, and the InsightOut feature:

- **Brightspace:** Brightspace is a versatile learning management system (LMS) used by educational institutions worldwide to manage and deliver online courses. It provides

educators and students with a platform for coursework, grading, discussions, and much more, facilitating a comprehensive online learning experience.

- **InsightSpace:** InsightSpace is the **envisioned evolution of Brightspace**, conceptualized to enhance accessibility specifically for students with visual impairments. It retains all the foundational features of Brightspace but with additional tools and functionalities to ensure that all educational materials are accessible to students regardless of their visual abilities.
- **Eduvision**: Eduvision is an **extension of Envision's services**, particularly tailored for the **educational sector**. It aims to **bridge the gap between visual content** and **students with vision impairment**, ensuring equal access to educational resources. As a **web and app-based platform**, Eduvision is designed to **integrate seamlessly with existing LMS** like **Brightspace**, transforming it into **InsightSpace**.
- **Envision Ally:** Envision Ally is a part of the broader **Eduvision ecosystem**. In the education context, it is a **community-driven feature within InsightSpa**ce that encourages **collaboration and support** among students. Here, sighted students and those with vision impairments can connect with sighted students or "**allies**" **offering their assistance by providing explanations and insig**hts into visual content, fostering an **inclusive learning community**.
- **InsightOut Feature:** InsightOut is a **specialized feature within the InsightSpace platform**, representing the **actionable core of Eduvision AI** capabilities. It's an AI-powered tool designed as a **plugin** that, **when a visual piece of content is uploaded, automatically processes and interprets the data**. InsightOut provides audio descriptions of visualizations,



detailing the type of visualization, key messages, trends, and other significant data points. This allows students with vision impairment to understand and engage with visual content through audio explanations.

So, InsightSpace, powered by Eduvision and enriched with the InsightOut feature, offers a comprehensive and inclusive educational experience. It enhances the accessibility of Brightspace's solid foundation, ensures content is perceivable to all students, and encourages a supportive learning network through the Envision Ally initiative. This cohesive system exemplifies a shift towards an education that is truly inclusive, where technology serves as a tool to level the playing field for every student.

Eduvision - Envision for Education

Empowering Inclusive Learning Experiences

Envision for Education is an innovative platform that embraces the power of research and human-centered design to empower inclusive learning experiences. Grounded in extensive literature research and employing methodologies such as value-sensitive design and inclusive design, our platform takes a holistic approach to address the challenges faced by visually impaired students in accessing educational content. Through a deep understanding of their needs, we have developed a comprehensive solution that combines cutting-edge technology with inclusive practices.

How does Envision for Education work?

For visually impaired students like persona "Nina", Envision for Education becomes their gateway to a all-in-one accessible learning. Nina simply uploads her educational files (e.g. pdf books, lecture slides, ect.) directly from Brightspace into the Eduvision platform. Once there, she can easily browse through the content, magnify it, and have previously inaccessible documents made accessible again using Envision's OCR (Optical Character Recognition) system that converts an image of text into a machine-readable text format, providing the option of text to speech and audio description

What is Eduvision?

Envision for Education, an extension of Envision's Special Education Program called Eduvision, is a web and app based platform designed to break down barriers and provide inclusive access to visual educational content. By seamlessly integrating with existing learning management systems like Brightspace, Envision for Education offers a comprehensive solution for students with diverse visual needs.

How does Envision for Education work?

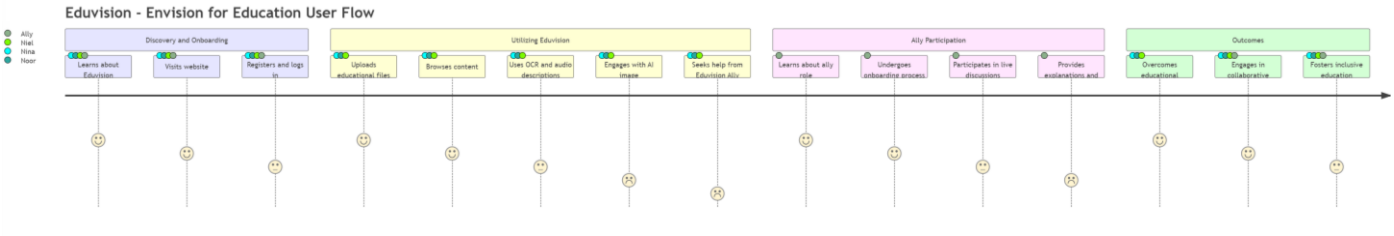
For visually impaired students like persona "Nina", Envision for Education becomes their gateway to a all-in-one accessible learning. Nina simply uploads her educational files (e.g. pdf books, lecture slides, ect.) directly from Brightspace into the Eduvision platform. Once there, she can easily browse through the content, magnify it, and have previously inaccessible documents made accessible again using Envision's OCR (Optical Character Recognition) system that converts an image of text into a machine-readable text format, provigin the option of text to speech and audio description

But it doesn't stop there. Envision's AI image segmentation recognizes figures within the documents and provides explanations from the overview of the visualization, type of the visualization (e.g., table, graph, bar chart, pie chart, etc.) and most noticeable key message of the visualization (e.g., trends, picks, certain numbers or colors) , ensuring Nina can fully understand and engage with the visual elements.

If the AI is unsure or not concise enough, Nina can effortlessly seek help from the vibrant Eduvision Ally community, a diverse group of students supporting each other through live discussions and shared knowledge. For instance, persona "Ali", a sighted classmate who wants to become an ally. Ali learns about Envision for Education through a campus poster, instantly recognizing the value of supporting fellow students in their educational journey. After an educative onboarding process (including learning how to clearly learn and describe academic figures) , Ali becomes an active participant in the Eduvision platform. He discovers questions from other students seeking help and realizes that he can contribute his knowledge and expertise in real-time through live discussions.

Ally system based on engagement and support enables collaborative learning leading to the ultimate goal of inclusion for and beyond the scope of visually impaied students, but other

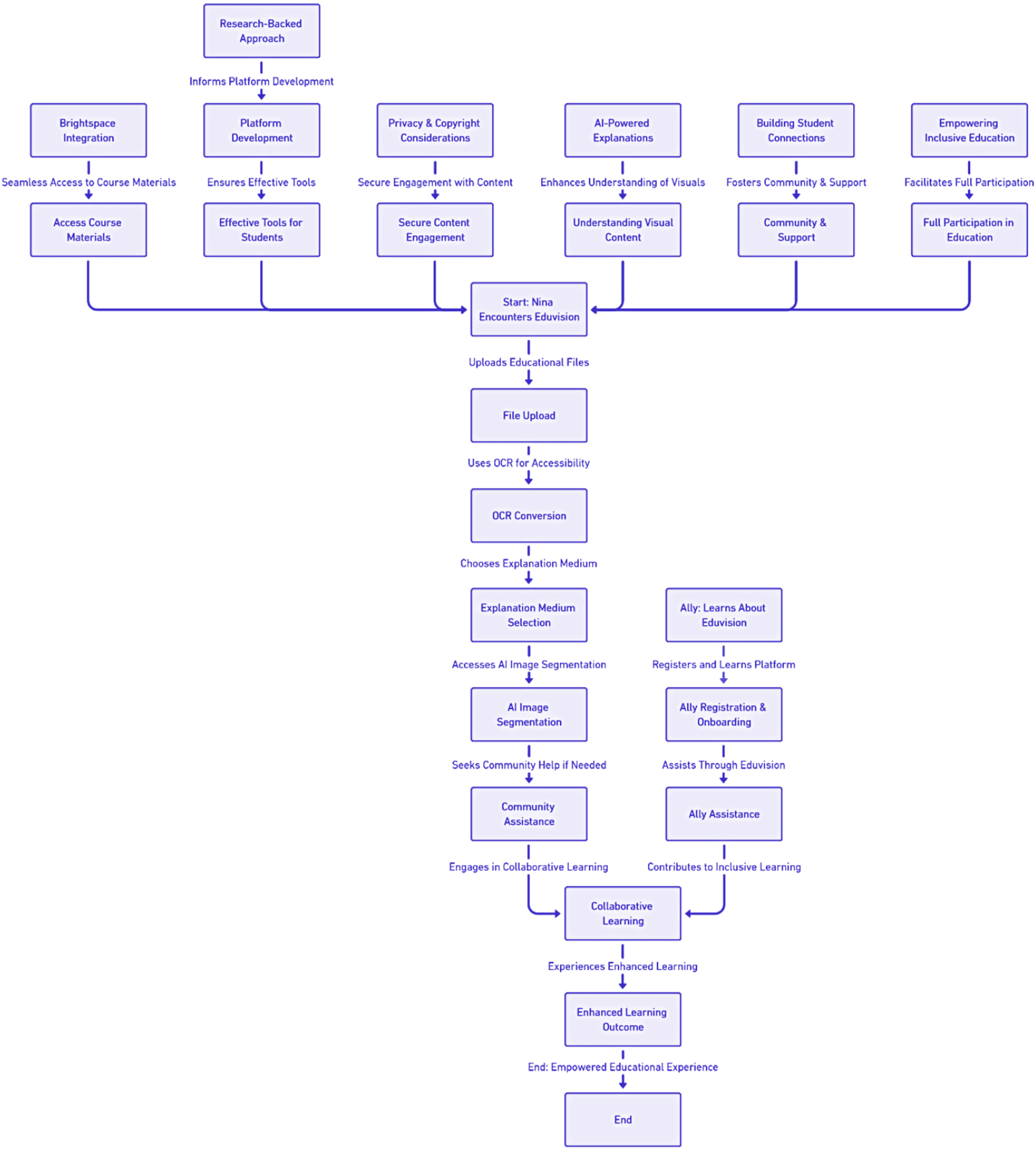
differently abled fellow classmates such as people with neurodivergence and dyslexia.



Why is Envision for Education essential for students?

1. **Research-Backed Approach**: Envision for Education is built on a foundation of extensive research, drawing insights from over 80 literature sources and in-depth interviews. By incorporating the latest findings in inclusive education, we ensure that every aspect of our platform is grounded in best practices and proven methodologies. This research-driven approach guarantees that our tools and features are effective and beneficial for students.
2. **Seamless Integration**: Envision for Education is seamlessly linked to Brightspace, ensuring a smooth and efficient workflow. Students can access their familiar course materials directly within the platform, eliminating the need for complex navigation between multiple systems.
3. **Prior Knowledge Integration**: Envision for Education acknowledges that students often come to the platform with existing knowledge about the material. By providing a familiar and integrated learning environment, Envision facilitates a more efficient and effective learning experience.
4. **Privacy and Copyright Considerations**: Envision for Education respects privacy and copyright concerns by working within the established learning management system. Students can confidently engage with the content while adhering to necessary regulations and guidelines.
5. **Overcoming Material Challenges**: Envision for Education recognizes the inherent difficulties posed by visual materials, such as infographics and charts. By providing comprehensive explanations and fostering a supportive community, the platform empowers students to overcome these challenges and excel in their studies.
6. **AI-Powered Explanations**: Envision for Education leverages advanced AI algorithms to provide clear explanations for visual elements such as tables and graphs. This groundbreaking technology empowers visually impaired students, like Nina, to fully understand and engage with visual content that was previously challenging to access. Our AI-driven explanations bridge the gap between visual information and comprehension, enabling students to excel in their studies.

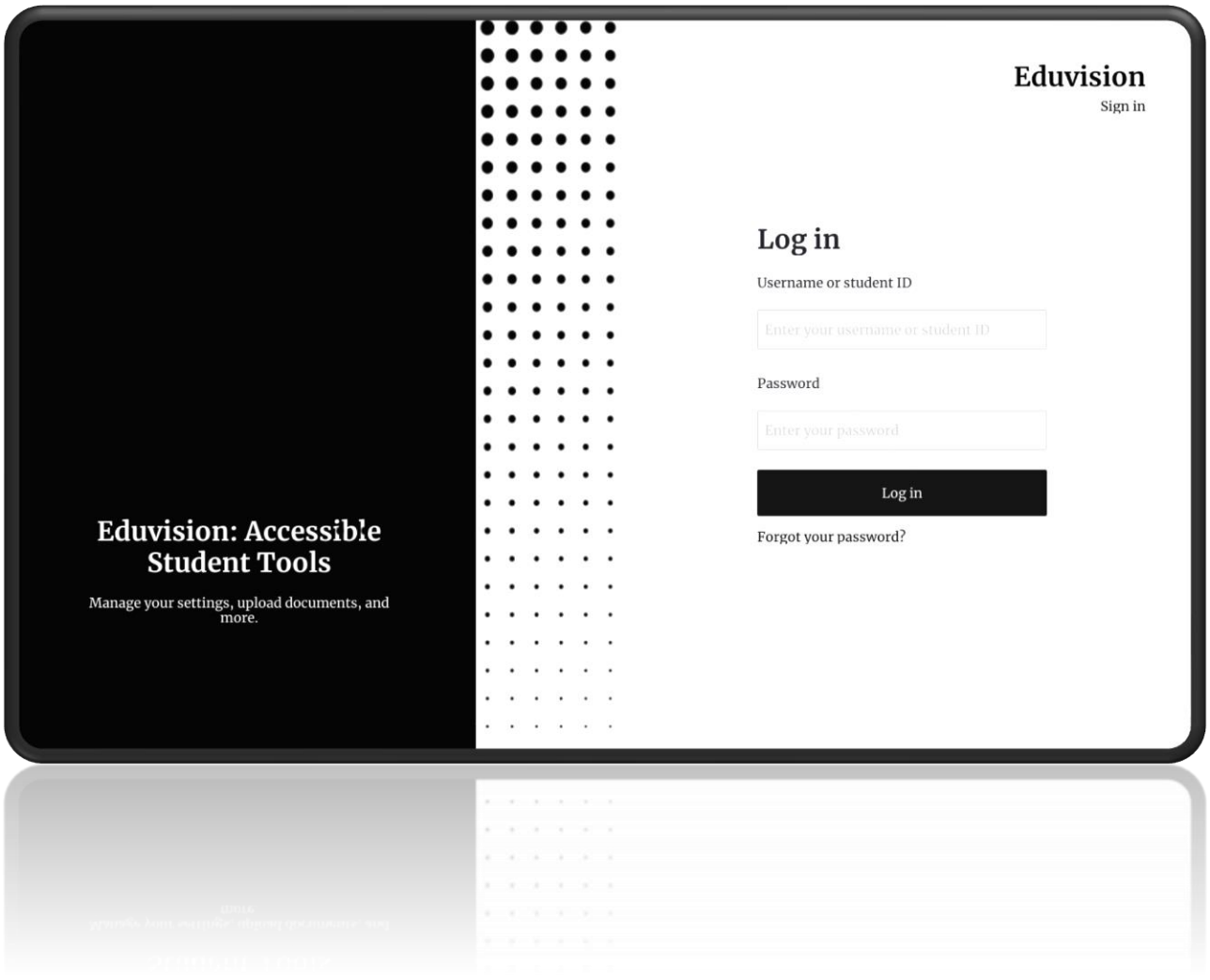
7. **Building Student Connections**: Envision for Education is not just a tool; it's a community. By facilitating interactions and collaborations between students, the platform fosters a sense of belonging and support. Together, students create a bond that extends beyond classroom walls, nurturing a supportive network that enhances the educational experience for all.
8. **Empowering Inclusive Education**: Our platform goes beyond mere accessibility. We are committed to empowering visually impaired students to reach their full potential academically and personally. By fostering a sense of belonging, providing comprehensive tools, and facilitating collaboration, Envision for Education ensures that every student can participate fully and excel in their educational journey
    - Deliverable Service Blueprint for developers
    - User journey for stakeholders
    - Screens
    - AI prototype + plugin development and codes
    - Scenario evaluation


Research-Backed Approach
Informs Platform Development
Brightspace Integration
Platform Development
Privacy & Copyright Considerations
AI-Powered Explanations
Building Student Connections
Empowering Inclusive Education
Seamless Access to Course Materials
Ensures Effective Tools
Secure Engagement with Content
Enhances Understanding of Visuals
Fosters Community & Support
Facilitates Full Participation
Access Course Materials
Effective Tools for Students
Secure Content Engagement
Understanding Visual Content
Community & Support
Full Participation in Education
Start: Nina Encounters Eduvision
Uploads Educational Files
File Upload
Uses OCR for Accessibility
OCR Conversion
Chooses Explanation Medium
Explanation Medium Selection
Ally: Learns About Eduvision
Accesses AI Image Segmentation
Registers and Learns Platform
AI Image Segmentation
Ally Registration & Onboarding
Seeks Community Help if Needed
Assists Through Eduvision
Community Assistance
Ally Assistance
Engages in Collaborative Learning
Contributes to Inclusive Learning
Collaborative Learning
Experiences Enhanced Learning
Enhanced Learning Outcome
End: Empowered Educational Experience
End

Eduvision Wireframes

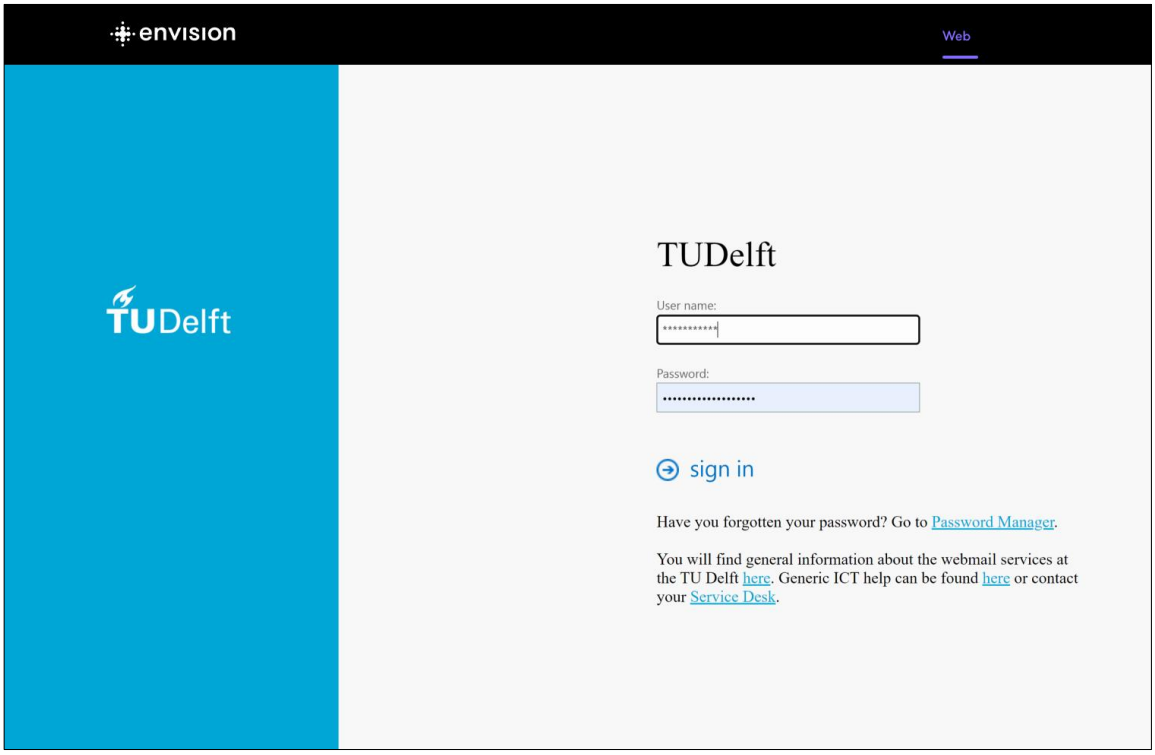
Please visit this link for the interactive video displaying Eduvision prototype:

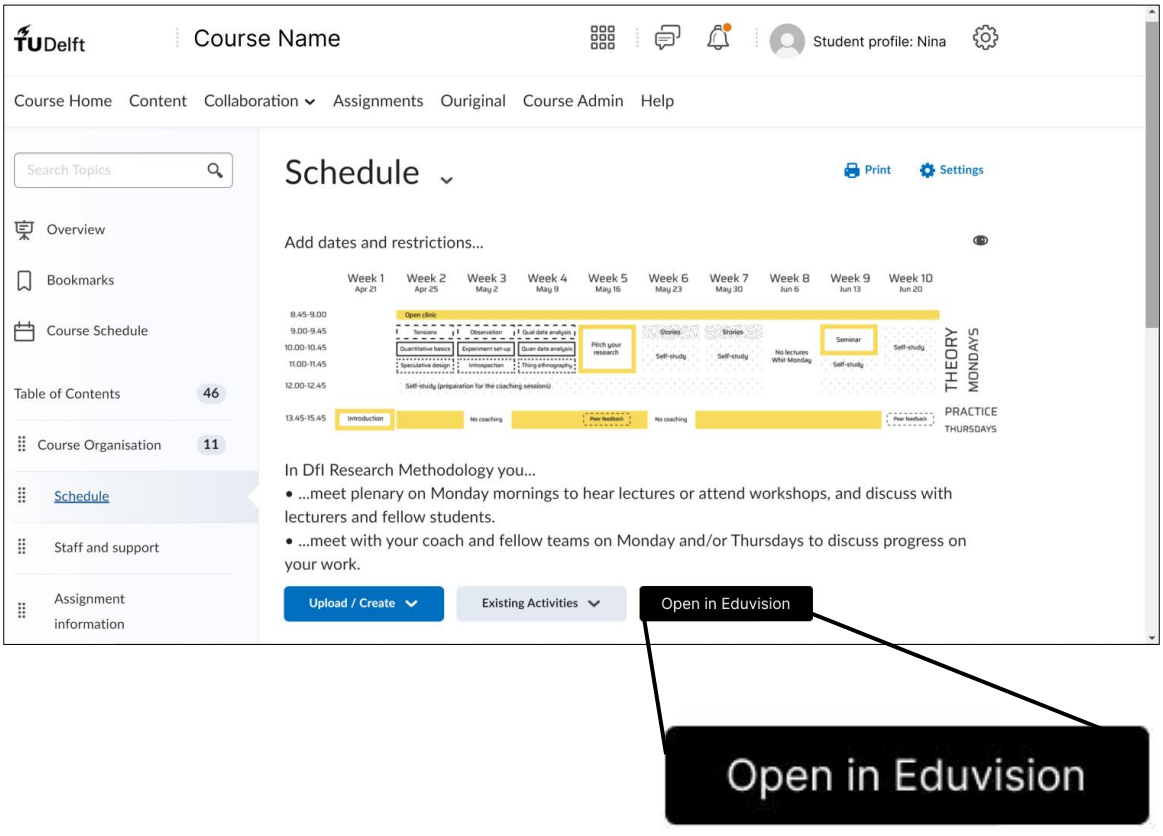
1. **Landing Page and User Onboarding**
    - Screen 1: Welcome Page
        - Brief introduction to Eduvision.
        - Sign-in/Registration option.
    - Screen 2: Registration/Sign-in Page
        - Accessible form fields for visually impaired students.
        - Option for sighted students to register as allies.



2. Integration with Brightspace

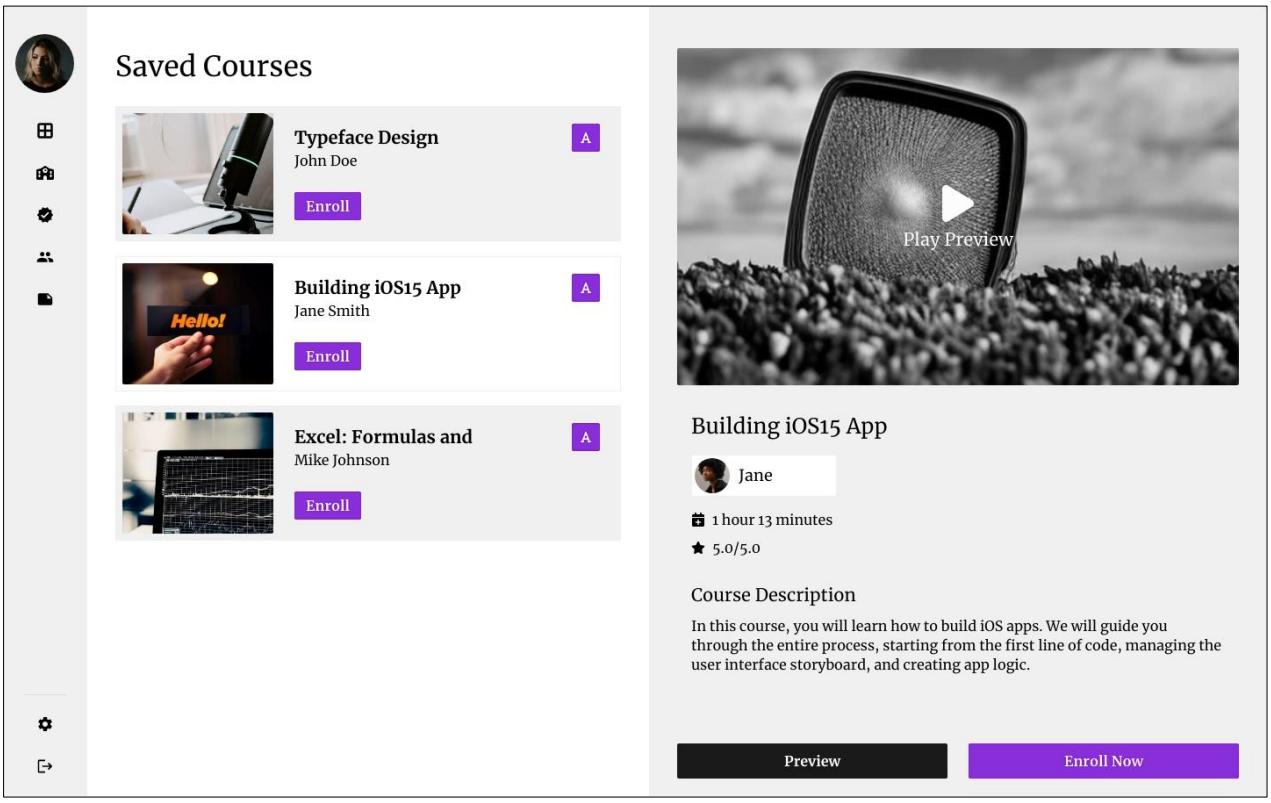
- Screen 3: Course Material Import
    - Option to link Brightspace account.
    - Interface to select and import educational files

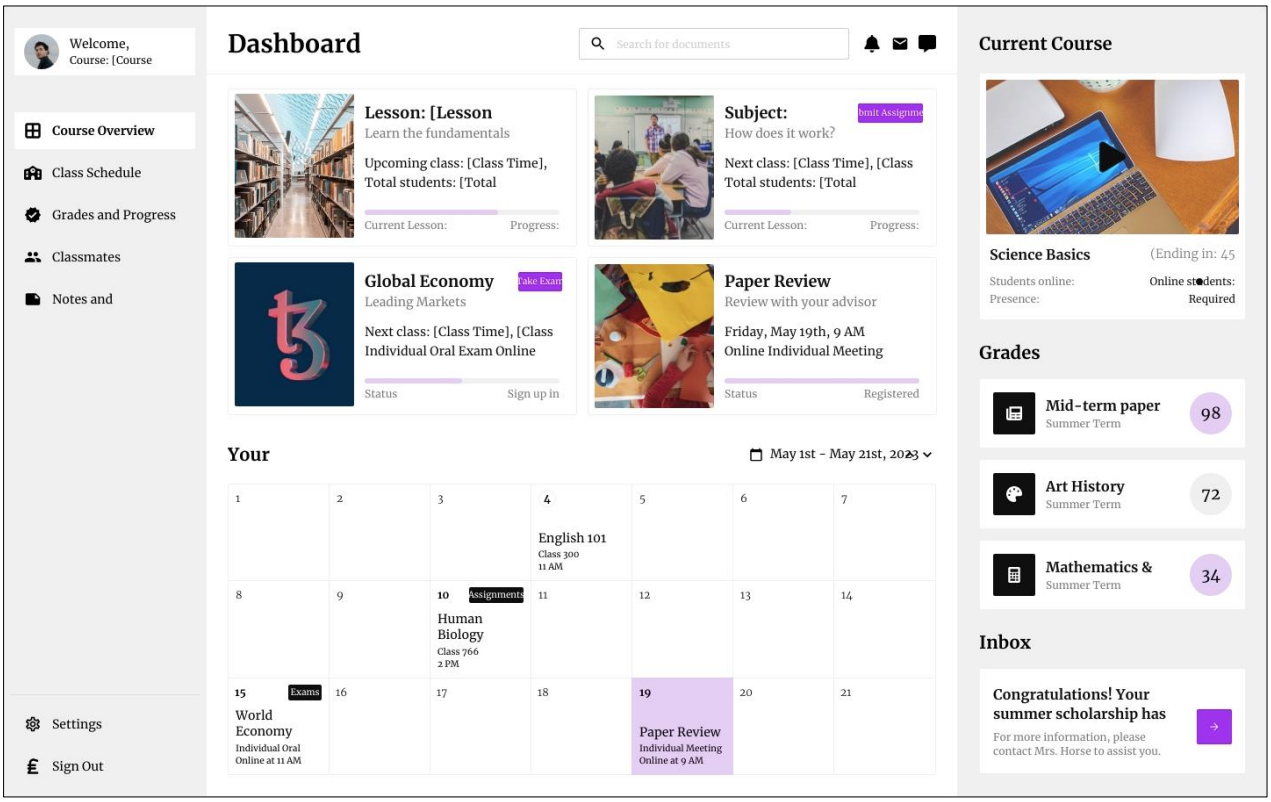




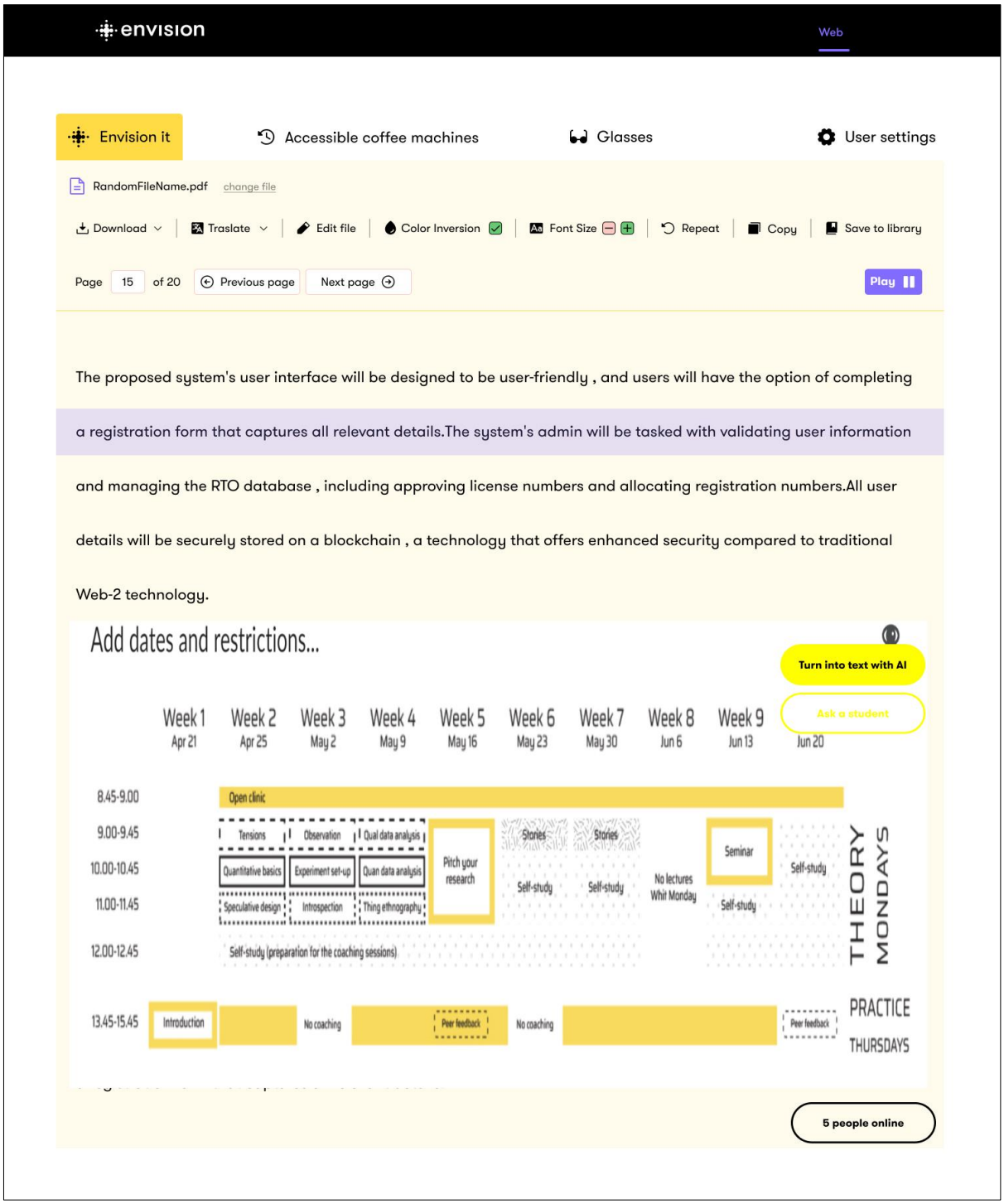
3. Content Browsing and Accessibility Features

- Screen 4: Dashboard with Uploaded Materials
    - List of uploaded documents with accessible navigation.
    - Options for magnification, text-to-speech, and audio description.



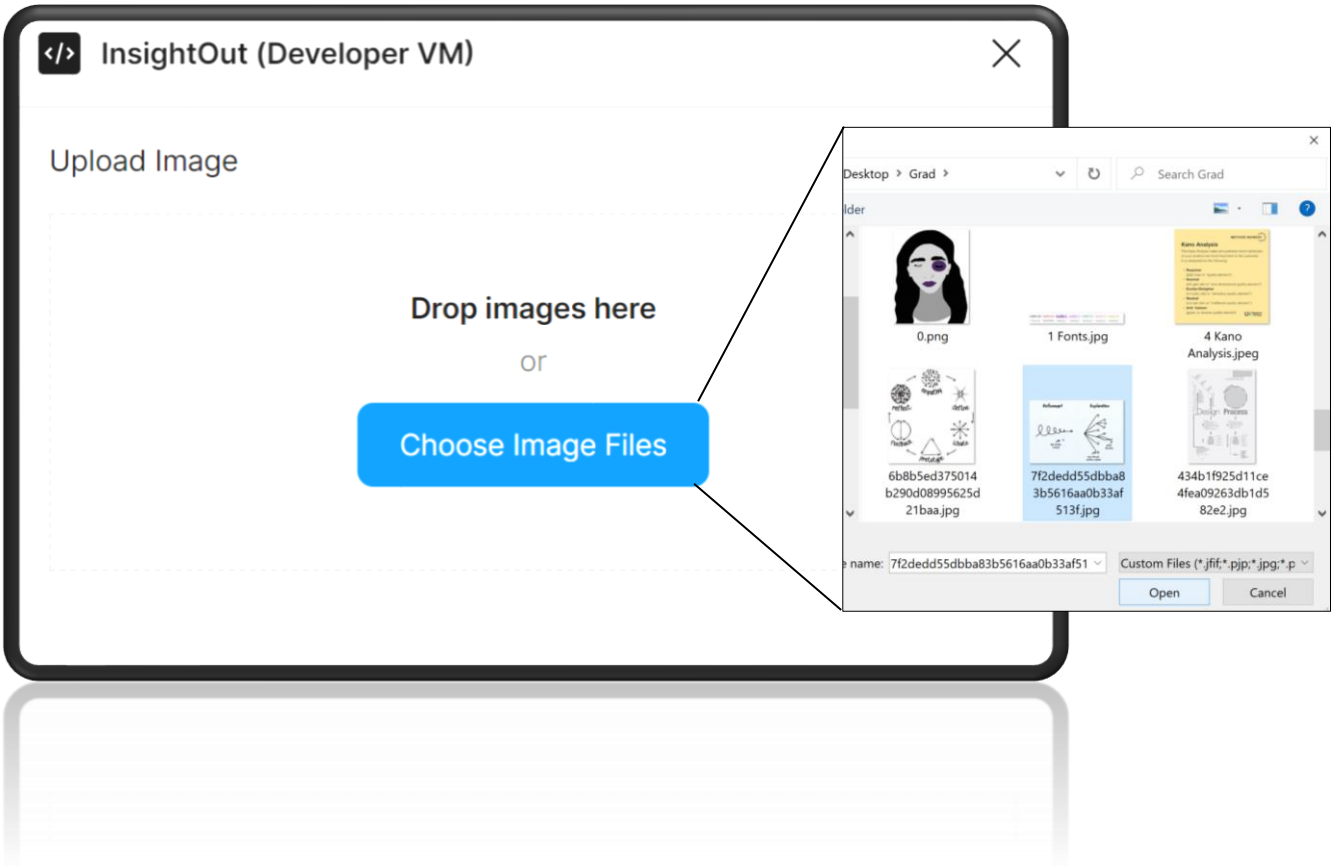


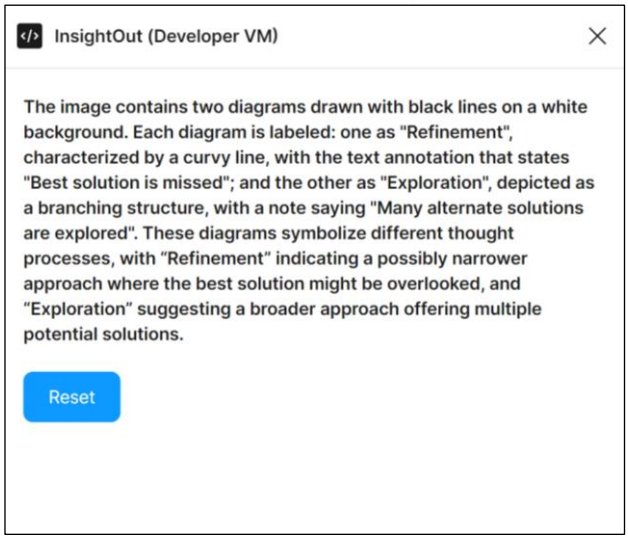
- Screen 5: Document Viewer
    - Interactive features for reading and understanding content.
    - OCR functionality for converting images to text.



4. **AI Image Segmentation and Explanation**
    - Screen 6: AI Analysis of Visual Content
        - Display of AI-identified figures with descriptions.
        - Mockup of AI functionalities and plugin integration.

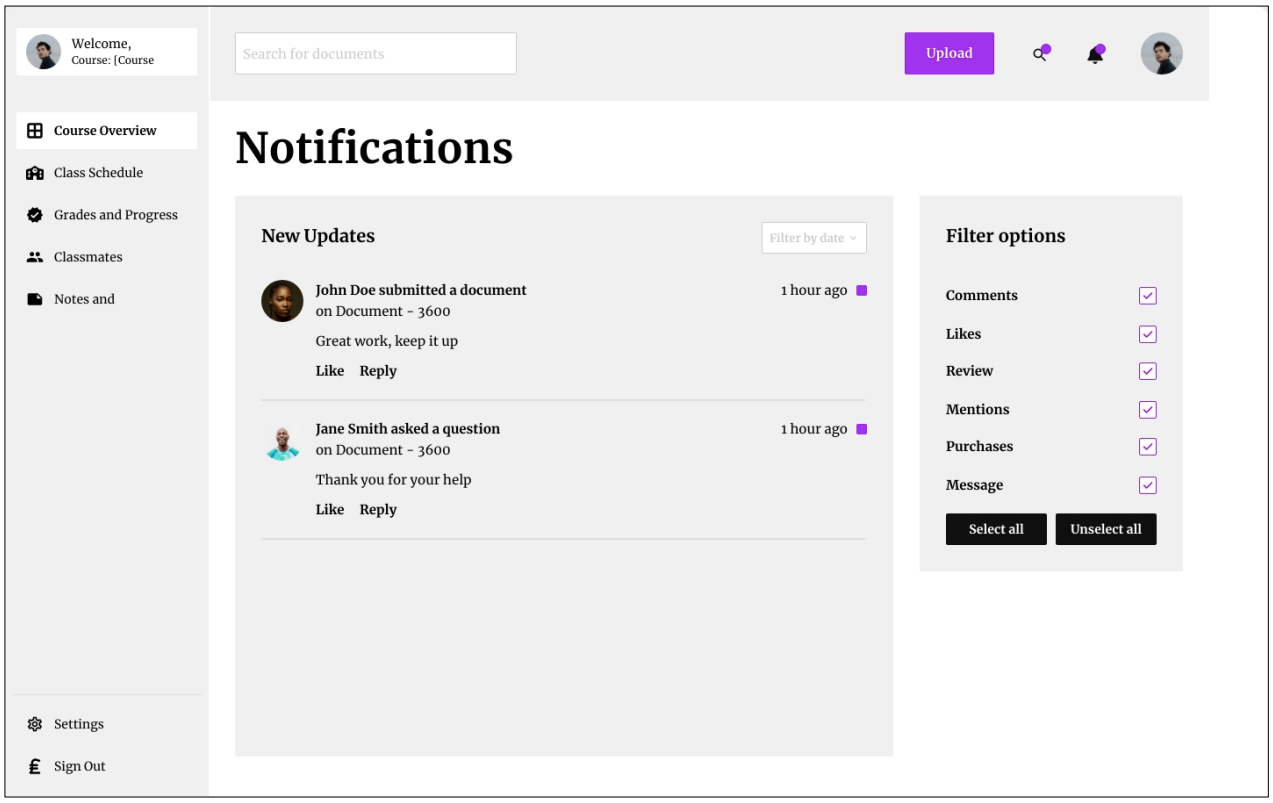
Please visit [this link] for the interactive video displaying InsightOut prototype:





AI Prototype Interface: https://github.com/RojinMoghadam/InsightOut

5. **Community Engagement and Ally System**
    - Screen 7: Eduvision Ally Community
        - Forum for students to ask questions and share knowledge.
        - Real-time discussion and support features.
    - Screen 8: Ally Onboarding and Training
        - Educational content for allies to learn effective communication.



6. **Privacy and User Settings**
    - Screen 9: Privacy and Settings
        - Options to manage account settings and privacy preferences.
7. **Feedback and Support**
    - Screen 10: Feedback and Help Section
        - Interface for users to provide feedback or seek assistance.

Conclusion:

The journey from concept to concrete product is unveiled in this chapter, presenting the high-fidelity prototype of Envision for Education. The transition of the traditional Brightspace platform to the newly envisioned InsightSpace is marked by the integration of the AI-powered feature "InsightOut", part of the Eduvision suite designed for inclusive education. This phase is meticulously crafted, detailing a service blueprint for developers, comprehensive user journey maps for stakeholders, and the development of AI components essential for operation.

The InsightSpace Experience

InsightSpace is the evolution of Brightspace, reimagined to support students with vision impairment. It maintains the core functionalities of Brightspace but introduces enhanced features for accessibility. At its heart is "InsightOut", an AI plugin that transforms visual content into accessible formats, providing audio descriptions of charts and graphs, ensuring all students have equal access to educational materials.

Eduvision: The Engine Behind InsightSpace

Eduvision extends the capabilities of Envision's technology, specifically for the educational sector, by breaking down barriers to visual content. It enables seamless integration with learning management systems like Brightspace, thus forming the backbone of InsightSpace.

Envision Ally: Fostering Community and Support

Envision Ally is a collaborative feature within InsightSpace, encouraging students to support each other. Sighted students become allies, providing assistance and fostering a sense of community that goes beyond traditional educational support.

The InsightOut Feature

The InsightOut AI feature is the standout innovation of InsightSpace, capable of interpreting and narrating visual data. It allows students with vision impairment to engage with visual content through detailed explanations, ensuring they can understand and interact with their study materials as effectively as their sighted peers.

Key Achievements of InsightSpace

- Provides an all-in-one accessible learning platform, directly uploading files from Brightspace/InsightSpace to Eduvision.
- Employs Envision's OCR technology to convert text and images into accessible formats like audio descriptions.
- Uses AI image segmentation to recognize and explain figures within documents.
- Enables students to request help from the Eduvision Ally community for further explanations.

Value-Driven Design

- The design of InsightSpace is underpinned by a commitment to the following principles:
- Accessibility and inclusiveness are at the forefront, removing barriers, ensuring ease of use.
- Personalization allows for a tailored user experience, catering to individual needs.
- Safety and security are prioritized, especially for users in new or unfamiliar digital environments.
- Support community collaboration, promoting a supportive learning network.
- Evaluation and Metrics
- To measure the effectiveness of InsightSpace, the following metrics are established:
- Accessibility is assessed by the ease and independence with which users can access content.
- User engagement and feedback gauge inclusiveness and the platform's ability to foster a sense of community.
- Customization is measured by the number of personalized settings utilized by users.
- User satisfaction and product durability indicate the quality of the platform.

Future Directions

InsightSpace stands as a testament to the potential of inclusive design in education. It encapsulates a deep understanding of user needs, aligning with the design implications and values identified throughout the research and development process. As an accessible educational tool, InsightSpace invites further research and practice to expand its capabilities and reach, ensuring that every student has the opportunity to learn and succeed in a truly inclusive environment. The platform's future lies in the collective hands of developers, educators, and students who will continue to shape its evolution towards an even more empowering and accessible educational landscape.

Chapter 4: Conclusion

InsightSpace:

Broadening Inclusive Education Horizons for Vision Impairment

Envision for Education Platform Evolution:

InsightSpace transforms Brightspace to better serve visually impaired students, integrating the "InsightOut" feature from Eduvision for a fully inclusive educational experience. This involves a detailed blueprint for developers and a user journey map that informs intuitive design and AI development.

Key Features:

- ***InsightOut AI**: Translates visual data into accessible content with audio descriptions.*
- ***Eduvision Integration**: Seamlessly blends with Brightspace to enhance user accessibility.*
- ***Envision Ally Community**: Encourages peer support and collaboration within InsightSpace.*

Achievements:

- ***Accessibility****: Streamlines the upload from Brightspace and utilizes OCR for content conversion.*
- ***Community Support****: Bolsters learning through the Eduvision Ally system.*

Design and Metrics:

- ***User-Centric****: Focuses on accessibility, personalization, safety, and collaborative learning.*
- *Metrics: Evaluates platform success through accessibility, engagement, customization, and user satisfaction.*

The Way Forward:

InsightSpace, embodying inclusive design, demonstrates a deep understanding of users' needs. Ongoing research and community collaboration will continue to refine and advance the platform's reach, ensuring equitable education for all students.

Introduction:

Briefly, we outline what the chapter covers.

Summary of key findings: Recap the main research questions and the results obtained. No new data should be presented here; the focus was on synthesizing the findings.

Discussion and Interpretation

- compare, contrast, and relate results to the theory or findings of other studies.
- Situate your findings within the broader context of field. Discuss what these results mean and their importance.
- identify and explain any unexpected results.

The project's culmination in the creation of InsightSpace, enriched with the InsightOut feature, presents a compelling case study in the field of inclusive educational technology. This final chapter draws on in-person user tests and validations, both with actual users and participants simulating real user scenarios, to offer a comprehensive analysis of the project outcomes.

Comparative Analysis:

InsightSpace's design and functionality are rooted in the principles of inclusive design and accessibility, echoing the ideals of the UDL framework. The project's AI-driven features, particularly the OCR and AI segmentation capabilities, are reminiscent of the assistive technologies discussed by the World Wide Web Consortium (W3C, 2020) which emphasize the need for adaptable and responsive tools to cater to diverse learning needs. The active involvement of sighted students as allies aligns with the community-oriented learning models advocated by Wenger (1998), reinforcing the value of collaborative and social learning environments.

Broad Contextual Relevance:

By situating the research within the broader context of the digital transformation of education, the findings highlight the urgent need for platforms like InsightSpace that prioritize accessibility.

The project's results are timely and relevant, as they offer a blueprint for educational institutions adapting to an increasingly online learning environment—an adaptation accelerated by global events such as the COVID-19 pandemic (Bao et al, 2020).

Unexpected Outcomes and User Test Insights:

The high engagement and enthusiast of sighted students feedback for the Envision Ally feature was an unexpected yet welcome result. It suggests a broader cultural readiness to embrace inclusive practices. The user tests revealed that participants, when engaged in a supportive environment, were eager to contribute to a shared learning experience. These findings underscore the potential of educational platforms to serve as catalysts for community-building and peer-to-peer support, echoing the sentiment of Zhang (2012) regarding the role of technology in facilitating collaborative learning.

Design Thinking Analysis:

1. Desirability (Human-related aspects of design):

Reflects the project's primary objective and design goal, focusing on the user experience and emotional engagement with the platform.

- **Key Points from User Feedback:**
    - The user interface design resonated well with students, aligning with the principles of empathy and inclusivity.
    - The platform's accessibility features significantly reduced the frustration typically associated with inaccessible content.
    - There was a strong sense of community building, suggesting that the platform met users' needs for belonging and collaboration.
- **Value-Sensitive Design:**
    - Emphasizes the importance of aligning the design with the psychological and emotional needs of students.
    - The platform's features were iteratively refined based on direct feedback, ensuring they met the real-world demands of the users.
- **Stakeholder Reflections:**

- Interviews with students provided qualitative data that highlighted the platform's success in creating a more inclusive learning environment.
- The stakeholders' map was utilized to ensure all relevant user groups were considered during the design process.

2. Feasibility (Technology-related aspects of design):

Assesses the platform's practicality, accessibility, and usability, ensuring the design is not only conceptually sound but also operational.

- **Insights from Prototype Evaluations:**
  - Users experienced a decrease in the time taken to complete tasks, indicating an efficient design.
  - The AI features, including OCR and image segmentation, were successful in accurately interpreting visual content for users.
  - Users reported high satisfaction with the assist of the AI, noting it significantly improved their ability to access content.
- **Technical Assessments:**
  - Detailed usability tests with students validated the functionality of AI features.
  - Accessibility audits were conducted to ensure compliance with international web accessibility standards.
- **User Experience Metrics:**
  - The platform's effectiveness was done through user performance metrics, such as task completion and error.

3. Viability (Business-related aspects of design):

- Addresses the potential for the platform to be adopted by educational institutions and its sustainability as a long-term solution.
- Stakeholder Engagement Outcomes:
  - Educators and administrators recognized the potential for the platform to be integrated into existing learning management systems.
  - There was an acknowledgment of the need for such inclusive technologies in the education sector.

- Potential for scaling up the platform was seen as viable, with educators showing interest in broader implementation across disciplines and institutions.

- **Market Readiness:**
  - Discussions with secondary stakeholders such as university educators and diversity and inclusion officers argued the readiness of the market to adopt such an innovative

Safety needs (Personal security, employement, resources, health, property)	**Certainty**	**Safety**	The design should **prioritize safety and security** for visually impaired students, especially in **unfamiliar environments**.	• number of **incidents** or accidents that occur • **level of risk** associated with different tasks • the **effectiveness** of safety features
		Affordability	The design should be affordable and **cost-effective**, especially given the limited resources of visually impaired students.	• **cost** of the product or service compared to **alternative options** • level of financial burden on students • **impact** of cost on student **satisfaction**
		Support	The design should provide support and **assistance** to visually impaired students, especially in navigating the challenges they face as students with disabilities.	• **number of support requests** received • level of **satisfaction** with the support provided • **impact** of support on student **success**

    educational tool.
  - The potential for InsightSpace to address a market gap in inclusive education was explored.

- **Scalability Considerations:**
  - Viability assessments included considerations of cost, resource allocation, and potential barriers to widespread adoption.
  - The business model was developed with an eye toward future growth and the ability to adapt to changing educational needs.

Design Implications Analysis:

Evaluation and Checklist Marked with the Concept:

Physiological needs (air, water, food, shelter, sleep, clothing, reproduction)	**Accessibility**	**Usability**	The design should be **easy to use** and **intuitive** for visually impaired students.	• **amount of time** it takes to complete tasks • **number of errors** made during navigation • **level of frustration** expressed by the student

- **Accessibility:**

  Platform is designed for ease of use, allowing students with disabilities efficient access to information.

  Utilizes OCR and AI to convert text and images into accessible formats.

Safety needs (Personal security, employement, resources, health, property)	**Certainty**	**Safety**	The design should **prioritize safety and security** for visually impaired students, especially in **unfamiliar environments**.	• number of **incidents** or accidents that occur • **level of risk** associated with different tasks • the **effectiveness** of safety features
		Affordability	The design should be affordable and **cost-effective**, especially given the limited resources of visually impaired students.	• **cost** of the product or service compared to **alternative options** • level of financial burden on students • **impact** of cost on student **satisfaction**
		Support	The design should provide support and **assistance** to visually impaired students, especially in navigating the challenges they face as students with disabilities.	• **number of support requests** received • level of **satisfaction** with the support provided • **impact** of support on student **success**

- **Safety**: Designed with consideration for the safety of visually impaired users, especially in new settings
- **Affordability**: Structured to be financially attainable, provided by educational institutions and as their responsibility to diversity and inclusion, considering the constraints of students.
- **Support**: Strong support systems with peers and classmates in place to assist students through educational challenges.

Love and belonging (friendship, intimacy, family, sense of connection)	**Inclusiveness**	**Inclusiveness**	The design should promote inclusiveness and provide a **sense of belonging** for visually impaired students.	• **level of engagement** and participation in class discussions • **number of social interactions** with peers • **feedback** received from students regarding their sense of belonging
		Integration	The design should **integrate seamlessly with existing tools and technologies**, to minimize friction and disruption to visually impaired students' daily routines.	• level of **integration with other tools and technologies** • number of **errors or disruptions** encountered during integration • impact of integration on **task completion**
	Equity	**Accessibility**	The design should provide **easy access** to educational **resources** and **services** for visually impaired students.	• **time it takes to access** course materials • **number of steps** required to complete a task • **level of support** required

- **Inclusiveness**: The platform supports all students, ensuring no barriers to access.
- Integration: Seamless compatibility with existing educational technologies.
- **Ease of Use:** The user interface is intuitive, simplifying the completion of complex tasks.

Esteem (respect, self-esteem, status, recognoition, strength, freedom)	**Independence**	**Independence**	The design should enable visually impaired students to **navigate and interact with their environment** independently.	• **amount of assistance** required to complete tasks • **time it takes to navigate** a new environment • **level of confidence** expressed by the student
	Flexibility	**Customization Personalization**	The design should allow for **personalization** and **customization** to meet the unique needs of visually impaired students.	• **number of customizations** made by each student • **level of satisfaction** with the customization options • **impact** of customization on **task completion**

- **Independence**: Features promote autonomous use, enabling students to navigate and interact without constant assistance.
- **Flexibility**: Adaptable to various learning environments and student situations.

- Customization: Offers personalization settings for individual preferences and requirements.

Self-actualization (desire to become the most that one can be)	**Empowerment Growth Creativity**		The design should empower visually impaired students to be **confident**, **competent**, and **capable**, especially in their academic and professional pursuits.	• level of **self-efficacy** expressed by students • level of **confidence** in completing different tasks • the impact of the design on student **success**
	Quality		The design should be of **high quality** and **durable**, especially since visually impaired students may have to rely on it **frequently**.	• **level of satisfaction** with the quality of the product • number of **repairs** or **replacements** required • **durability** of the product over time

- **Empowerment**: Aids in making students feel confident and capable in their academic activities.
- **Collaboration**: Encourages effective communication and learning between students and educators.
- **Growth**: Supports students' personal and professional development aspirations.

Correlation with Maslow's Hierarchy and Fundamental Psychological Needs:

- **Security and Safety**: Accessibility and safety features create a secure environment.
- **Belongingness and Love**: Ease of use and inclusiveness foster a sense of community.
- **Esteem and Self-actualization:** Empowerment and growth opportunities enable students to realize their potential.

Value Checklist Aligned with Design Concept: The service is fully accessible and inclusive for visually impaired students.

- ✓ Priority barriers to learning and engagement are addressed.
- ✓ Designed for simplicity and intuitive interaction.
- ✓ Personalization options and easy to use.
- ✓ Prioritizes the safety and security of all users.
- ✓ Financial considerations are taken into account to ensure wide accessibility.
- ✓ Support is readily available and effective.
- ✓ Flexibility is built into the platform, catering to varied needs.
- ✓ Collaboration is not only possible but actively facilitated.

Evaluation and Measurement of Values:

The deep dive into the design chapter has showed the pathways to creating an inclusive educational platform that resonates with the needs and values of visually impaired students. The evaluation process aligns with the research-backed design implications and user values, ensuring the platform not only meets functional demands but also supports the emotional and psychological well-being of its users. With the groundwork established, the concept is poised to iterate and evolve, guided by user-centric insights and empathetic design approaches, ensuring the ultimate goal of fostering an inclusive academic experience.

Limitations:

The study recognizes its limitations, such as the sample size of user tests and the potential for a broader demographic representation. These limitations highlight the need for ongoing research, especially to determine the long-term efficacy and adaptability of the platform across different educational settings and content types.

Limitations in detail and possible effect on the interpretation of the results:

- sample size
- methodology
- data constraints
- questions that this study was unable to answer.
- Self-reflection

Contributions:

This research has bridged the previously identified gap in the literature and design world by demonstrating the tangible benefits of AI in enhancing educational content accessibility. It also contributes a novel perspective on the dynamics of educational communities within digital platforms, advancing our understanding of how technology can foster inclusive educational practices.

Recommendations:

For Practice: Schools and universities should integrate the findings to foster inclusive learning environments.

For Policy: Policymakers should consider mandating the inclusion of accessibility features in educational platforms to ensure equitable learning opportunities.

For Future Research: Further studies are encouraged to assess the long-term academic and social impacts of inclusive educational technologies.

General Recommendations: A call for cross-disciplinary initiatives is made to refine the integration of inclusive design in education further.

Final Remarks:

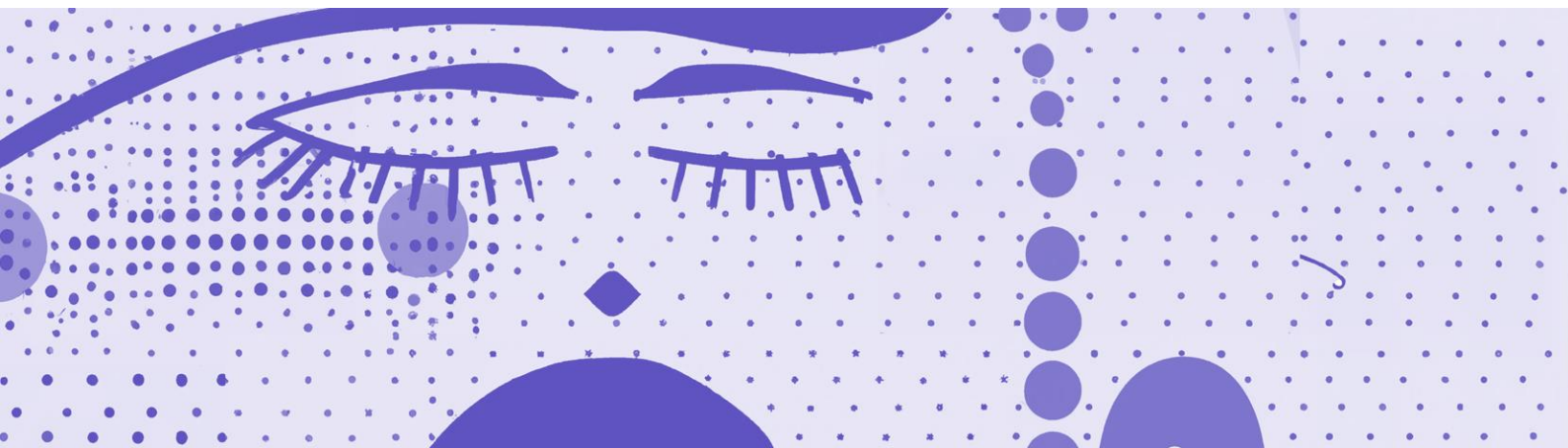
This project serves as an emphatic reminder of the transformative power of inclusive design in education. It is a call to action for all stakeholders in education to prioritize accessibility and inclusivity in the evolution of educational technologies.

The InsightSpace platform, with its innovative InsightOut feature, can become a pivotal event for inclusive education, championing the rights of all students to equitable and empowering learning experiences.

Introspection

In Delft University of Technology's corridors, where precision is priority and design require its due rationale, my journey as an intuitive designer unfolded. Shaping specific design engineers, often clashed with the untamed creativity I cherished. The process, demanding in its call for proof and validation, sometimes felt more like a trial than an education, challenging my natural design instincts that I shouldn’t rely on anymore.

This thesis is not just an academic exercise; it's a statement of a personal transformation. Each chapter, user test, and iteration marked a gradual shift from spontaneous creativity to a discipline rooted in evidence over intuition. Amidst sleepless nights and obsessive attention to detail, I learned it wasn't just about conforming to a stringent educational mold, but about serving the user, about a design that transcends personal ambition to embrace a broader humanity.



Yet, as this chapter closes, there's a part of me that yearns for the return of creative recklessness, for the intuitive spark that once defined my work. TU Delft, with its stringent demands, taught me the value of data and the power of validation, but it also took its toll, leaving a longing for the freedom that once was. As I stand at a crossroad, looking back critically, wishing for future generations of designers-to-be not burdened by debt, depression, or lost self-respect, but empowered and whole. A future where IDE is the nurturing ground that fosters true inclusivity—a place where creative souls are treasured, where the fire of originality is fanned, not quenched.

I call for a future of inclusive education that not only instructs but also inspires, that kindles every individual's spirit, embracing uniqueness and fostering a space where creativity and structure coexist harmoniously, where every creative spirit finds its place and thrives.

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NOT THE END

Appendices

Appendix A - Approved Project Brief

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name: Ghorbani Moghadam
initials: R.G.M given name: Rojin
student number: 5088135
street & no.:
zipcode & city:
country:
phone:
email:

Your master programme (only select the options that apply to you):

IDE master(s): ( ) IPD (★) DfI ( ) SPD
2nd non-IDE master:
individual programme: - - (give date of approval)
honours programme: ( ) Honours Programme Master
specialisation / annotation: (★) Medisign ( ) Tech. in Sustainable Design ( ) Entrepeneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair: Dr. Dipl. -Des. Stella Boess dept. / section: IO Applied Ergonomics
** mentor: Dr.ir. Lavinia Marin dept. / section: TBM Values Technology
2nd mentor: Ferkan Metin
organisation: Envision
city: The Hague country: Netherlands

comments (optional): While IO scholars are overburdened with mentorship; Dr. Marin's research in Value-based Design, with inclusivity as the core value of this project, & TBM approaches bring a fresh perspective to the viability side of this DFI project.

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair Dr. Dipl. -Des. Boess, S.U. date 17 - 05 - 2021 signature Stella Boess - IO Digitally signed by Stella Boess - IO Date: 2022.05.17 16:46:27 +02'00'

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair. The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: 37 EC

Of which, taking the conditional requirements into account, can be part of the exam programme 30 EC

List of electives obtained before the third semester without approval of the BoE

★ YES all 1st year master courses passed

○ NO missing 1st year master courses are:

name C. van der Bunt date 20 - 05 - 2022 signature C. van der Bunt Digitally signed by C. van der Bunt Date: 2022.05.20 12:41:36 +02'00'

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **. Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: ★ APPROVED ○ NOT APPROVED

Procedure: ★ APPROVED ○ NOT APPROVED

comments

name Vicky van den Elsen date 24 - 05 - 2022 signature Vicky van den Elsen Digitally signed by Vicky van den Elsen Date: 2022.05.24 13:44:24 +02'00'

Inclusive Education for Students with Visual Impairment — project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 01 - 11 - 2022 — 30 - 03 - 2023 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Inclusive design is an approach for improving accessibility for people with disabilities (Walsh & Wronsky, 2019). A design project related to inclusive education for students with vision impairment at the higher education level involves several key stakeholders. Students with vision impairment, stand as the target of this research considering the experiences and challenges they face within the context of education with vision impairment (Figure1). Additionally, educators and administrators at higher education institutions play an important role because they are responsible for providing support and accommodations to students. Design thinking ability may act as a mediator between an independent variable (e.g., problem-solving ability) and a dependent variable (e.g., math scores). The use of Envision glasses and AI technology is one potential solution to the challenges faced by students with vision impairment at the higher education level.

Envision is a startup company founded as a result of the Yes!Delft incubation facility at the Technical University of Delft. Envision employs artificial intelligence to facilitate interaction and communication between people with varying degrees of visual impairment and the rest of the world, with the goal of assisting them in becoming more independent in everyday life. This promise is fulfilled by the human-centric approach of creating solutions for and by users in order to make the result relevant to them.

The following Envision products are currently available (Figure2):

- Envision App: that is available for both iOS and Android.
- Envision Glasses: adapted on Google Glasses to use the power of speech to make everyday life more accessible for any visual impairment.
- Envision Ally: the video calling feature for the visually impaired to connect with others and let others be their eyes to ask for help and guidance.

The importance of inclusive higher education for visually impaired students has grown in recent years. One possible solution is to use assistive technology, such as Envision AI, which has object recognition and text-reading capabilities. Visually impaired students can gain easy access to a variety of educational materials and resources by using the camera on Envision Glasses, increasing their independence and allowing them to fully participate in the educational process. This project aims to investigate the potential of Envision Glasses to improve the accessibility of higher education for visually impaired students and to design a system that can be easily integrated into the existing educational infrastructure. The use of Envision glasses in a higher education setting could provide numerous benefits to students with vision impairment. For example, the glasses could assist students in accessing printed materials such as textbooks and class notes by providing audio descriptions of the text. This could greatly improve their ability to participate in class and complete assignments. Furthermore, the glasses could provide real-time audio descriptions of visual aids and other materials used by instructors during lectures, allowing students with vision impairment to fully engage with the material.

There may also be challenges for inclusion a higher education setting; this project will investigate how Visually Impaired Students (VIS) in the higher education (HE) setting could be supported, whether Envision services fit this or what design could help in this situation. For example, the glasses may not be appropriate for all students with vision impairment because they may require specialized training and support to use the technology effectively. Furthermore, the glasses may be prohibitively expensive for some students, particularly those who do not have access to financial aid or other forms of assistance.

Overall, the use of the Envision App and Glasses has the potential to significantly improve the educational experience of visually impaired students while also promoting a more inclusive, hence accessible higher education system.

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introduction (continued): space for images

image / figure 1: Persona: Some of the challenges that visually impaired students face.

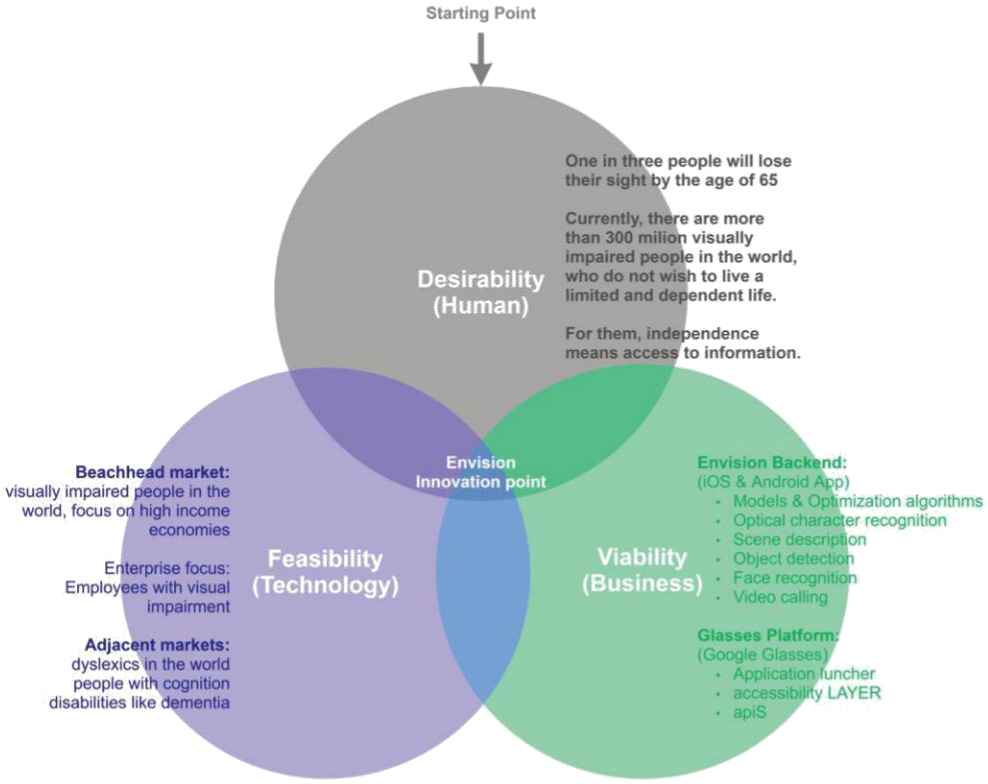


image / figure 2: Context: Human, Technology, Business sides of the innovation by Envision.

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Transitioning to higher education (HE) is a major transition for many students (Kovač 2015). The main obstacles were social, personal, content-related, and organizational (Perry et al. 2001). Students with visual impairments struggle to read and get to lectures and work groups independently (Hewett et al. 2018).
Despite the UN Convention on the Rights of Persons with Disabilities, universities still don't have digital accessibility (Dangoisse et al.,2019). Students with vision impairment may face additional challenges in higher education. compared to their peers without vision impairment, they are less likely to attend and graduate from college. It can be assumed that there is lack of support services or college accommodations, difficulty accessing course materials, taking notes in class, or navigating campus, despite existing accommodations such as screen readers, braille displays, electronic magnifiers, note-taking assistance, orientation, and mobility training to help navigation inside campus.

Envision glasses have the potential to add value for VIS beyond the tools currently available. This technology gives information without occupying hands, provides real-time access to class schedules, campus maps, and other useful information for visually impaired students. Envision Glasses or a similar technology could also provide vision-impaired students with assistive technology like text-to-speech and speech-to-text software. however, there is a gap in knowledge on whether the Envision technology fits the needs of students of higher education and how its functionalities would support their studies. That way it fits the challenge in your introduction and sets a problem that is feasible to address within the scope.
This research will question: The situation of inclusion or exclusion of students and the reasons behind it.
What are the experiences, desires, and needs of students with visual impairments in higher educations?
This project will study those desires and needs of visually impaired students in context and how these needs could be supported through design. In order to reach this goal, measurable values of inclusivity -containing accessibility within it- must be identified. Further explanations comes in the Approach chapter of the proposal.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

Designing a tools that improves the sense of inclusivity for students with visual impairment.

The goal of this project is to create a tool that creates a more inclusive education for students with visual impairments in higher education by demonstrating how fostering certain types of interactions or enhancing accessibility, such as navigating through campus, understanding visualized information, one-on-one tutoring sessions, group discussions, or collaborative projects, can help these students achieve a sense of inclusivity.

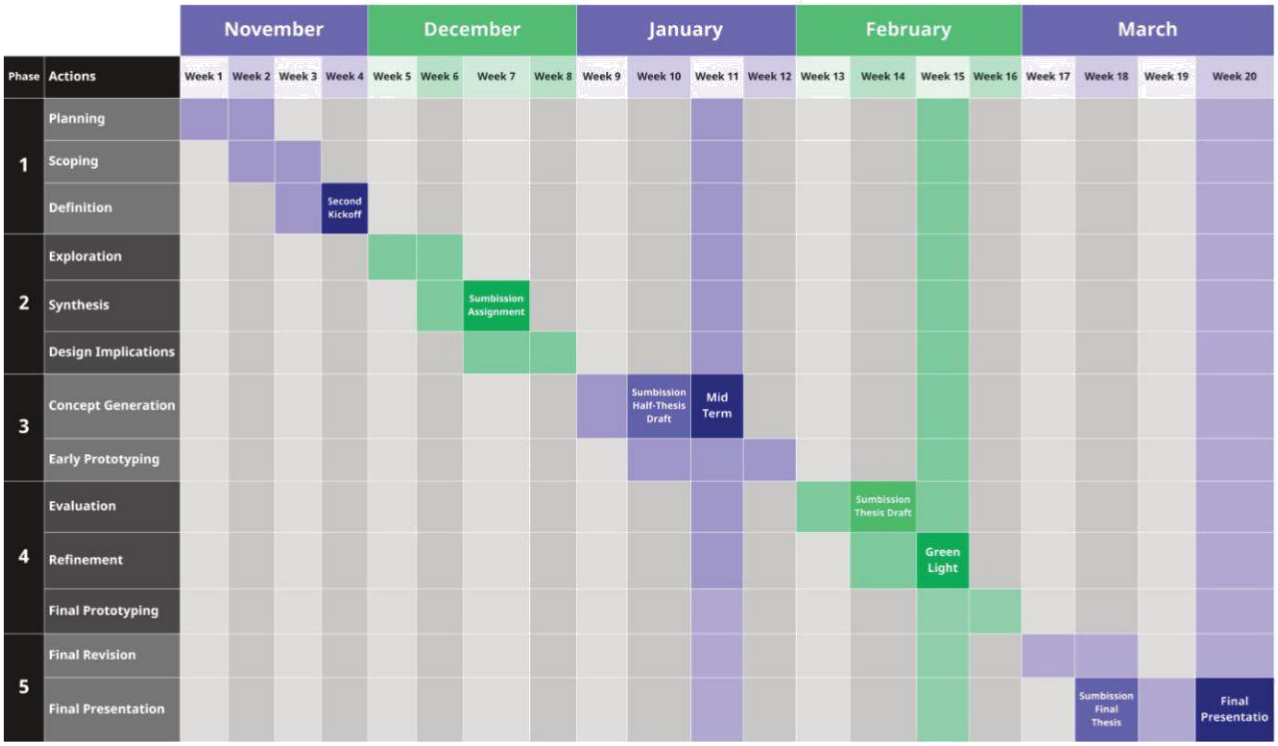
The target group is students between the ages of 18 and 25 who are currently enrolled in higher education institutions (such as collages and universities). Consents and ethical measures are more sensitive and beyond the scope of this project before the age of 18. Customers who pay for the service include educational institutes, diversity and inclusion departments, educational grants, and insurance companies. These stakeholders are not the primary focus of the study, but they will be useful in developing design implications, validation variables, and checklists.

To achieve this goal without jeopardizing inclusivity for other groups of diversity, values of equitable access, success, and quality in higher education will be defined. "Quality is positioned as a complex generic concept, while access and success are identified as key concepts in the social inclusion domain, supplemented by the concept of participation (Gidley et al., 2010)." Iterations on the current Envision services and interventions on educational platforms are possible directions to respond tho the mentioned questions and achieve the goal.

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 1 - 11 - 2022 30 - 3 - 2023 end date



November - Insights included in the planning, scoping and definition: Set of desk researches including literature, stakeholder mapping , and concept mapping will be used to first explore and then narrow down the project scope based on design gaps, existing facts and situations, or limitations.
December - Exploration, Synthesis, Design Implications: Exploratory methods of field research, including semi-structured interviews, observations and surveys, will be used to discover experience touch points in a qualitative manner. Backup methods such as quantitative survey and crowd sourced- data will be used to validate qualitative findings.
January - Concept Generation (midterm): Concept generation will be throughout series of co-creation sessions, ideally involving target user participants, otherwise together with experimenting visual impairment on regular participants to discover opportunities or problems.
February - Prototyping, Evaluation (Greenlight): Prototyping is an iterative method to test and develop the chosen concept along the way. As much as limitation of participants and time allows, test will be run to enhance the concept prototype and prepare it for the final presentation.

This project will use design thinking. This method emphasizes target group empathy. Project or research study scoping involves setting limits and boundaries. Identifying stakeholders and creating a research question or hypothesis are often required.
I anticipate iterative and immersive changes to the context, brief, idea, and design. After defining the problem through exploratory literature and field research and identifying obstacles and facilitators, this project's design requirements will become clearer.
I have not planned specific holiday due to time constrains, but I will take breaks specifically on weekends.

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

My motivation to pursue this thesis project stems from how I define my personality and life goals. So I'd start with a brief biography. Nature inspires me, and I believe that we are all descended from it and will one day return to it. I define myself with a color code: light rouge, which is similar to how my name is pronounced, matches my feelings, and is also associated with the words "mellow" and "calm." As a DFI student, I am interested in human interactions in health-related contexts where AI is used as a tool or even as a character.

Design, to me, is a T-shaped knowledge that means creation. "Less is more," is my preferred strategy. I discovered the importance of design in healthcare, basic well-being requirements, and, eventually, the top of the pyramid: "Happiness." That is why I chose to focus on Medisign. In the future, I believe AI will no longer be an option, but rather a necessity for designers to survive. As a result, I'm looking forward to learning more about it during my research.

I want to learn a variety of skills for my graduation project that will help me in my future career. During my elective semester, I took classes that emphasized user research and the importance of making the design process human-centered. So, in order to improve this skill, I'd like to focus more on researching the user and their context.

Furthermore, my previous interest in health and wellbeing, and how to incorporate it into the design process and design itself, led me to the inclusive design approach, which I would like to investigate further through this project. I am personally interested in education and inclusivity, and I believe that my design skills can be used to improve the university experiences of students with vision impairment.

I am also aware of the difficulties that students with vision impairment face in gaining access to education, and I hope to use my project to raise awareness about these issues and develop solutions to make education more inclusive for these students. I am very excited about the opportunity to work on my project, which I believe has the potential to make a significant difference in the lives of these students.

Aside from my personal interest in the topic, I am drawn to it because it aligns with my interests in interaction design. I am confident in my ability to design educational tools and resources that are accessible to students with vision impairment, and I am excited to apply these skills in a project that has the potential to improve the lives of others.

For my part, I'm interested in entrepreneurship, artificial intelligence, and multidisciplinary projects and approaches, as well as how they affect design and how design can be effective in this regard. As a result, I intend to incorporate such techniques into the project whenever possible in order to further investigate their potential.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Because of external circumstances and personal physical and psychological issues, the assignment was submitted in week 7 of graduation prices, and it is based on the project that was previously underway. As a result, my superiors agreed that the provided proposal s a viable plan.

Appendix B - Interview Transcripts

B.1 Participant I

- So from now on, I'm starting the recording. So just be comfortable. And let me know if at any point you wanted to stop or stop me with the questions. And anything he does is just very casual and exploratory. So I want to feel your experiences and memories, you know, not something very personal, but something that you feel okay sharing it.

- You also want a personal introduction of what my visual impairment is, or?

- Yeah, that's some part of that question. So I would like you to, I actually don't need an introduction from you, because you already told me that you studied Master's in Applied Geophysics at civil engineering. And you graduated in August. Yeah, correct. And was it? How long did it take you to finish the masters?

- The Masters was almost two years. So I did it in the two years. That's, yeah, that's the timespan.

- Yeah. So it's very impressive, because I'm kind of a neuro diverse. And I'm exceeding my two years limit already. So it's very impressive to finish in two years, I think with the workload of T Adele's. Yeah. What do you feel about it?

- Well, actually, it's a little bit double because I did a joint master's program. So I only did half a year to Delft, or like, in total year, but first half year to Delft, then I went to, to auto University. So I also went to Switzerland, and Germany. And then I came back to the to Delft for my master's thesis. So we didn't really have the ability to even extend our master's program, because you have to take all those courses at those different universities.

- So did you also have I'm just asking out of curiosity, did you have to write a thesis as well? Or is this course based on?

- No, I had a thesis at the end, which was half year, so semester, and I do Delft and a company. So I started that one in March, and then ended August.

- So it wasn't kind of a graduation internship. Yeah. And so how did you experience that? Studying? You know, I assume Applied Geophysics. I don't have enough information about it. But it's very, it seems to me very sciency. And mostly reading materials, but not as much as, for example, our program that is very practical, and you have to build stuff, you know, you have to design stuff. And how is it? So explain, Is this what you were looking for?

- we have of course, some courses, which has a lot of in the literature research, I do the reading myself, actually, I never used for a job or anything, I just read it myself using a magnifier software on my computer. But we do also have practical classes, because we also have field work. And geophysics is really studying the earth with measurements. So we also had some some field work. And of course it did locate sometimes it's a little bit more difficult, there are specific things that I cannot do. And for example of him falling in class, usually everything I can do a bit as soon as it becomes practical. You have to search for other solutions of all at this instance, everyone knows that field work, you work within a group. So you can combine the workload I can there are things that I can do and are things that are not that suitable for me this so someone else can do it. So that's usually how we solved it.

- Perfect. So you had the chance in most of your courses to work in groups. But have you also experienced individual courses that required field work? Or I don't know?

- o. So no field work is actually never alone. It's always been a group.

- It's just a basic template of the rubric of the courses in ITU def, or other universities is exactly similar to us, actually.

- It's also not feasible to with that equipment. It's very heavy and very, it's a lot of work to set it up. Yeah, you won't have enough time on your own

- s it like like typography and using those cameras and stuff to it see similar

- but we actually do the subsurface. So we put for example, we have this we have seismic so you put all kinds of sensors on the subsurface, and then you make some noise, put it as the accent some sound wave acoustic waves into the subsurface and they refract back and then you can say what kind of layers you're dealing with in the subsurface for example, sand or clay.

- Yeah, so interesting. You know, these, these are not in my question. I'm just so curious about this geophysics, too. Trying to understand it. Because also I had another friend as a civil engineer who was studying to something else. But it's about you know, studying the clouds and the sky. Better climates,

- yes. or No to track. Just changed names.

- Yeah, I don't remember the name, but but I'm always curious to know which of these programs study what and stuff? So, um, yeah. Do you mind if I asked? How old are you? And when you started? The bachelors here?

- I'm now 24 years old. And I started the bachelor back when I was 17. And back in 2016.

- yeah. And did you need to move to Delft? or your parents or your family?

- I moved to Delft from the shaft and had lunch. So it takes me at least three hours to get to. So yeah, I had to get a room here.

- Okay. Yeah. Like, the other day students who get these accommodations from TU Delft, right?

- Probably, yeah, well, no, not all Dutch students get it. These days. It's actually you have to wait on a waiting list together? No,

- I know, it's because it's impossible for us. I thought maybe more Dutch students are able to get it because of the list. But it's still not that. It's still

- very difficult. But I actually was lucky. Thanks to my visual impairment. I had a meeting with my city advisor when I started my bachelor before before I started my bachelor. And he was like cycling in Delft is pretty dangerous. I still do cycle myself. But it was like, That's try to minimize it as much as possible. So we're going to arrange that you have room on your campus? Yeah. So if you had you Oh, I actually got my own studio, right from the start of the semester. So I actually got really lucky with that one.

- Yeah, perfect. And didn't manage to give you the closest building of Devo possible.

They did. I mean, not per se the closest but I think to possible you have to do you know the vocal? Yeah, I do. So I live in the white one.

- Yeah. Get the hall. Yeah, exactly. It's pretty

- close to civil engineering, which is on that side of Exactly. Very good enclosure, if you took the gray ones, for example, but it was completely fine. They paid attention to making sure it was a room close to civil engineering, and walking distance

- and relocating and living on your own. Did it happen for the first time you live when you were doing that? And of course, it's challenging for everyone. How did you experience it?

- I actually kind of like it. I was really looking forward to go studying live on my own and just the whole student's life, you know? Yeah. And it didn't. It took it took me a long time to adapt actually, like I was pretty fast used to it. Yeah, no, I just really liked it. With the new start actually, New Start New City.

- Yeah, perfect. And yeah, and now behind me think so. Okay, now, if you don't mind, of course, could you explain the level of your vision impairment and if you have a story behind it, if it's gradual, or it was, you know, from a certain age, basically, if you, you can just explain as much as you want.

- So I have albinism, it's a genetic disorder, which means that I was actually born with albinism. My parents noticed from the start I, you might know albinism from animals. For example, I was born very pale. I had like I had really white hair, or at least a little bit more blonde, but I used to have really white hair. So actually, from my birth, my parents knew there was something out I'm a free mate three months, I already got diagnosed with having albinism. So I've had the same visual environment like the same degree of environment for actually all my life, it remained stable at 12%. That's my eyesight. To give you more of a practical view on it, everything that you will see on eight, eight meters distance I will only see in one meter distance. And then I'm mostly talking on the details. Not that I can see that far. But it's just just the details that you see at eight meters.

- Exactly. So it's like did you try using glasses or what kind of devices basically you started using at La early ages,

- while glasses don't really work because there's an there's something wrong with the nerves between my eyes. My, my brain. So you cannot change it with glasses, basically.

- Oh, was it automatic?

- Yeah, it's automatic. Okay, but is it not comfortable for you?

- It's okay. Or actually, I'm gonna switch. Maybe we can just go sit over here. It should be fine. And I have my head. Yeah. It's okay, that's okay. That's good. Yeah. I have no idea. It's a question everyone has me. Okay. No worries, I will see some losses. Yeah, so glasses don't work. This is only for if you are seeing that far. Close, I'm not sharable to English drums aren't for that, actually.

- Because you can also switch to Dutch whenever you feel it's comfortable. I know some that fit. It can also get help later on to understand it.

- But I mean, I do wear glasses, mostly for the sudden I've been wearing sunglasses from an early age, she had noticed by now I'm very light sensitive. It's also part of albinism, actually. So from an early age, I actually didn't use any age, any glasses, any anything that I needed at that time, I could still continue my life as a child. It was from I think my from primary school. And when you start to read books, and you have to look to the blackboard, for example, at that time, things started to change. I feeling very old, if I talked about that I had those a three books release, or they printed out the big books which I which has larger letters so that I could follow, they had a place in front of the front of the class. So the Blackboard was close to it. And I could also just walk to it and back then that gradually changes as our electronics became better and better. So I got a laptop at some point I got a camera which I which was connected to my computer where I could look or which I could video stream the blackboard with

- perfect, you could zoom into Blackboard whenever you wanted

- to. I just have this camera connected. And I could just handle it on my computer and zoom in zoom out change colors, whatever I would feel like. And I've actually been using those two Sol computer with magnifier software. And that's camera. I've actually been using that since primary school, the end of primary school up till the end of my master. Those are actually the main things that I used. They tried to get me on a cane as well. But I never liked that. Because I mean I do cycle still. Yeah. So I didn't feel comfortable walking with a cane as well. Because why would I need it if I also cycle

-- I can imagine. And you also said that cycling is a bit risky. Have you experienced any difficulties? What are the certain experiences that you had with it?

- Usually cycling goes pretty well. I haven't had any bad accidents with it yet.

- Then I kind of routine. Yeah,

- exactly. But there are some difficulties. For example, if you have to cross a busy road, like it's very hard to estimate how far away carnage I don't see that that I cannot estimate how far away it is. So then it gets difficult if it's very busy. I'm not sure when I can cross the roads for example. So that's like the main issue. Other than that, cycling is usually actually actually fine. I cars are big enough to notice people are big enough to notice. I usually learn my route pretty fast. Like I knew depth pretty fast already when I was cycling through it in the beginning of the year of the year, most bachelor you mean so that usually goes pretty fast, but it's just if it's really busy and you have to cross busy roads, then it gets more difficult

- I can imagine. Yeah. And you mentioned learning the ropes and also within the campus. Do you have a because different people have different interpretation is learning curves for navigating and understanding being in a space. Can you explain it to me like how do you usually do that and how you do just try for several times and you remember it memorize it. The first

- thing I usually try to do and it's tough doesn't have that but I've used that on all my experiences abroad is to on the internet, look up a map or the map of the building you Ya know, what's this, like this building this room can be fun, that isn't gonna be fun. It's very unfortunate to delve doesn't have that, too. But that's what I used to do when I started. For example, in Switzerland, I was only there for half year. And it's very hard to get to know all the rooms. And it's really convenient that you just have a map of where you can look up. Where's this building and various room in this building? Yeah. So that's usually the first step that I do. Another one is, yeah, I just, for example, civil engineering building, I just go there and you start searching for connections. So for example, is our the lecture what are the names of the lecture halls? What's their order? Like? Where can you find them? And for example, the second floor and up, those are mostly offices, but they all have numbering so you kind of remember around which, like, have each numbers on which side like,

- patterns? Yes,

- back to the next. Details also work. For example, if you have a change in color for the floor, just plan something I just say, bring them. But that also usually helps like a recognition, you can recognize it, because it's usually always there. So it's a combination of finger really, I think it's being details patterns.

- And I'm curious to know that when you want to, for example, you are looking for a certain room, in a map that does that map tell you that okay, you have to go to the second floor and be on this side of the building. I don't know the left wing, for example, and after I don't know certain rooms there is this hole, for example? Or is?

Or does it? You know, does it help you to see and imagine the mark of the building and try to you know, I don't know how to explain it, but just imagine the whole building and then place that room in your, in your mind that it should be there. Or it helps you easier to say if so someone or I don't know a description tells you go a lot last for I don't know certain meters, then go right, then go off then go was how does it work better? For me,

- the easiest is usually just having a map just just on that preferably online, of course, because then you can zoom in and out. And then you tried to oriented okay, I entered a building from here. Then I moved on, you see, okay, it's a second floors. Are you good? Yeah, you know, you have to stick to stairs to the second floor. And then what I usually do is link it to the method floor, link it to the, to the stairs that I took to get there which direction I have to go. But it's usually really based, I really have that that map in my head.

- I can. So yeah, so you mentioned that when you were at school, you had this camera to zoom into the board and stuff. And how was How was the experience at TU Delft? That was a bigger school, like, for example, in bigger lecture halls. When you couldn't sit very close to the board. What did you use? How did you experience?

- Well, actually, it was at the TU Delft, it was actually better to sit at the back with my camera. Because you know, when you're in the front, you have two scenarios where the whole gradually goes off. Yeah, as the seats go up, like, but the thing is, if you're too low, it's only it goes up very slowly. So you can still have the instance where there's this long shoot and sitting in front of you. And the camera can of course notes. It's not that you can't bend it that much like it's it's a pretty solid camera. So then it's like, okay, can I see anything? Because I'm looking at someone's hair or hoody or whatever they were wearing on their hands. Yeah. So I actually sat at the back, because then I have the overview of the whole classroom. And of course, I cannot read anything at the time, I cannot read the Blackboard and at all I can distinguish if they're, again, see if they're writing on it. So yeah, usually I just follow the lecture around, or at least, that's not true, by the way. You hear when they start writing on the blackboard and then yeah, okay, I see a person standing there him pushing me lecture. Yeah. And then I zoom in on that one. And the camera is is good enough to actually have a high enough contrast that I could actually always read it.

- And do you also take notes in the class or you do it afterwards?

- I do it in the class. So I actually learned myself to do everything on the computer because my handwriting is awful. I cannot read it back. So I learned myself to type every note and I also I also very I quickly learned to write mathematical formulas online, on my computer. So first in words later on, I switch to Overleaf. But I learned very fast typing that way. I was right. It was very convenient.

- Okay. Okay, very nice. But then you don't need to. I'm just trying to imagine that. For example, the camera is zooming to the board and you have it on your screen zoomed. And then at the same time you want to take notes. Do you do it on the same device?

- Yeah. So what do I usually have? Well, it depends a little bit on the course. But let's say we have our lecture writing on the blackboard, we have a PowerPoint presentation, also top and I'm trying to take notes. So what I usually had is I had one half of the screen, I had my, my camera, it was one half, then on one quarter writes up, or, for example, I had the presentation open, or usually it was a little bit larger. And I only had like this very small space of writing, because I never looked at what I was writing anyway. I just typed in blind and hope I

didn't make too many mistakes that I could read it on later. But usually it I never look at what I'm writing. For example, when I'm zoomed in, and I'm reading something I also that's a split screen. Yeah, I zoom in as much as I can only see the article that I'm reading, while my Word document, for example, or making notes is out of sight. Then I also just type blinds. Yeah, actually how I did it,

- but then you're an expert that you don't need to see what you're writing. Yeah, you're so accurate in typing. It's probably Yeah, it took a long time. Yeah, exactly. It is, like good ability. Yeah. Very nice. And but you don't like to use any kind of assistive device to help you take noting, have you ever tried something or you were not interested in that? You know, like that transcriptions, you know, voice into words?

- Yeah. No, I've never liked that. Because then you get like everything. Everything that's said, and you have to go over them later on anyway. Yeah, to show that it's like, Okay, you go to lecture and record everything. And then you have to read through the whole thing again. Yeah. So I prefer just taking notes myself, then I could also write it down in a way that I would understand otherwise differently formulated. And what the teacher would say, for example, are also skipped bars that I'm not interested in.

- Yeah, exactly. Your own interpretations helps you learn easier. Definitely. Yeah. Um, okay, very interesting. Have you had any experience any discrimination from certain group of group of people, either fellow students, or teachers or something like that,

- I'm only had experience with bad teachers in that matter. For example, in high school, I have two examples for you. Those are my basic examples that I am back in my high school. Like in the Netherlands, you have to choose between more technical profile or more towards languages and economics. So of course, wanted to do more technical because I wanted to go to the TU Delft, or at least I didn't know that by then. But it was my interest. And my chemistry teacher was also the heads of our school or like, not the heads of our school, but he was high in ranking. He said, like, No, you shouldn't do that. Because you're not able to do anything technical in the end anyway, you should just go do language interpretations like language translation. I was like, no, no. And I proved him wrong, of course, because I didn't do it. Yeah, I mean, in the end, he apologized, but I was a big thing at the time. But then I have an even worse example. was my teacher back in she was my geology teacher back in my bachelor. So in my bachelor, I took some geology courses of course, it's also including field work. And just looking at drug determining what kind of rock it is. So that's very visual. Yeah. So before the semester started, I went to her and that say like, Okay, can we get some of them? Can we adapt the course that I can also take it because I have to form a program? Because it's very visual and someone else can also just describe to me what they see. That's the same thing as me seeing it right. Yeah. To she was like, No, I'm not gonna do any anything different for you. You just have to do like the rest. You're not gonna get this degree anyway. Because you cannot see the rocks on Okay, she She almost got fired for that actually.

- Okay, good. Yeah. So the university supported you for that you report it?

- Yeah, I reported it. I went to my study. advisor was my go to at the time for every kind of problems. And of course, you have to settle at the new university. So there are some things to arrange. And I told him, I told my mentor at the time I had a buddy was also like, she went through me, with me through the building, for example, to get to know the building at the time, actually. So they really ended up going to the director of the faculty of this is a problem. And, yeah, later on, she still hadn't changed her mind. So I bought her course. And then we had to go fieldwork, and she thought that will be

too dangerous. So she didn't want to take me, then his other teacher was like, okay, then you're just right with me, and you're just on my group and like, okay, so yeah, that was really affected. It's usually from Up till now, I've usually had experience with with lecturers that are not that lecturers, teachers that are not understanding. But I think that's mainly because they don't know. They don't understand what a visual impairment is. It's very hard to imagine, of course, yeah. But they just see problems rather than, okay, we need to do something different. That's fine. How are we going to do with different?

- Do you think that something could have been done in terms of maybe making more awareness for teachers and lecturers to be able to understand it easier?

- I, you reached out to students on the back, right. Yeah. Good, Michael, thanks. I used to be the chair of students on the barracks back when we were starting up. And one of the things that we need focus on is getting awareness for lectures and other staff members have to delve, because the thing is, you don't specifically need that much adaptations to comfort someone to help someone out. And for example, for me, I only need to have I need to make my exams on my computer. And that's it. That's the only thing I need an extra time. So the only thing you have to arrange is that they have their exams on USB stick to give it to me on the computer so that I can make it Yeah, and make sure that the room is extended to 50% extra time. So it's booked to four and a half hours. It's a small difference to me to make, but they just don't know why it's important, of course, because otherwise, why would you do it if you don't know why it's important. But it's also just very small to do. And I think it's really important to let's just also other students that you cooperate with, with I mean, I was always very lucky, everyone was very understanding always, but just that students, teachers, staff members, just let them know why it's important. And how much of a big difference such a small step can make. Yeah,

- interesting. So you, you were mentioning that rocks, course, are the name. But then how did you eventually manage to understand the the inputs of the class? How did they adapt it for you?

- Well, the class I didn't really adapt, or it wasn't per se necessary, because you just pick a lot up from, like, what other people are saying or what the lecturer is saying. That's a simple example. This rock is usually has this shape kind of shape, and they can feel the shape, for example, or this kind of color or this kind of details. You just write it down anyway, and remember it. Yeah. And then for the exam, I didn't get a translator like say someone who said what's visible in the rock, or like how to rock look like, but I got some bigger samples that were awesome. Clear. Clear characteristics, like really that show decorators cigar

- shape? Hidden? Yeah. And in that course, you had this chance to actually touch the snows. Okay, so you could also fill it in. You could also put it closer. Yeah, exactly. Okay, nice. But have you ever experienced another kind, of course that requires something visual, but it's not tangible, right, like a stone.

- I had this one course where I had difficulties with and there was unfortunately not a solution for it. This was actually not going to Delft. This was at the University of enteric. Yeah. And we had this course, which was seismics EDOs acoustic waves that I told you about, which realize I'm not a particular fan of that method simply because the output is it's not really great to see it's just a grayscale with lines. And I had a very difficult time because we had this course where we need to learn how to process such such day. except to work with the data, interpret the data. And yeah, we couldn't really find a solution because I had to take that course. But I was, it was so difficult for

me to take this course because it was. Yeah. It was physically impossible actually, for me to do it. I and it was very tiring, of course, because you have to really focus on it. Yeah. In the end, yeah. We didn't get a solution for it. Because, yeah, it was too short of a time to arrange effects are and we could not think of effects, unfortunately. So there have been cases where not everything

B.2 Participant II

- So I'm recording. And I have this list of questions that I want to ask. But it's very open. So feel free to go beyond and just explain your anything you like. So my experience? Yeah, because it's very explorative at this point, I just want to know, anything. Anything that you want to tell me? Yeah, so you were saying, first of all, I would love to know that what what you're studying?

- I'm studying aerospace engineering. I'm a second year. So I pretty young still, I think, because I'm 19. Now. Yeah,

- so it's bachelor.

- Yeah, my bachelor. Yeah. So yeah, it actually goes pretty well, right now. I didn't feel any courses yet. Still need to recent one, though.

- Yeah. Good. Nice. Second year. Okay. So you started last year? None of it was in COVID? Or did you have any online courses?

- Yeah, we started. The first half year was online. And then it became hybrid. But that sucked, really. So I still got, I still went online for the first three quarters of the year, the last quarter. Finally, we could go to campus permanently again. That was really nice.

- And nice. And let me see. How do you experience these days for you basically, being in university? And, you know, I, I've heard that Aerospace is very difficult.

- Yeah, it's true. It's, it's like, it's very, it costs a lot of time, it's very time consuming. Especially with how much extra time I need to read. Because because of my disability. Basically, I'm really slow at reading because the letters and stuff, I need to concentrate a lot. Because without it just, it just really hard. So I actually get 50% extra time on tests, just like little tiny thing. And basically, I really need that time. Also, mostly, most of the times I make test, because it also depends on the subject, because sometimes like calculus to test is basically very much only an equation and just work it out. And I'm pretty efficient than working things out that I'm not efficient at reading. So if there's a subject where where there isn't, there is need of a big context like, like they give a paragraph to read you first, then it takes a lot of time for me.

- Yeah, I can imagine. Did you have most of your exams, online or on campus? And

- I do actually all my exams, I take them all on campus. In the tower of aerospace. Yeah. There's basically on the second floor, there's the academic construction stuff, but I got a separate room next to the academic counselor's office. And they just put a personal PC for me there. Yeah, and I get this laptop from the EU. And that's all the way clean. So I can see clearly can can get fraud or anything. And then I just make my tests there. And it's really nice, because at my last school in high school, I it was not as well arranged as it is now.

- So so most of your exams are here, but still it's on computer and not on paper.

- Yes, because I need to enlarge my clothes. Small letters, I can read those. That's also really nice. You can also see it on my phone. If I go to WhatsApp, it's all most of it isn't touch. So you can't even read it. I think

- I know a little bit of like, the letters are like way bigger than yours, I think.

- Yeah. And the contrast makes makes it easier for you to read. How about the black? You know, there are two ways like light background black background doesn't differ for you, which is

- comfortable. So actually, maybe I can first tell a bit about my visual disability because that's also nice for context, maybe Exactly. My visual disability is called Have a data need this? pigmentosa? It's always short into RP. Because it's basically getting it this means getting out. And that's your back of your eye. You know that?

- Yeah, I know that's I know that maybe in my language

- 89 English, I think, and pigmentosa is basically pigment pigment. So how my disease my visual disability works is it's a teacher, degenerative disease, so it slowly gets worse. It's also how do you call that? It's passed on. Yeah, it's a genetic disease. And basically, my body doesn't give enough

- it doesn't give enough stuff to my eyes to actually live. Understand. So my photoreceptors basically die out slowly. And with the dying out of the, of the photoreceptors, actually, the pigment spots are created by my body. This is not the reason of the dying out of the cells because the cells just die because they don't get enough. Nutrition nutrition. Yeah, nutrition. That's the word. Yeah. So they don't get enough nutrition and, but it's separate from the pigment stuff. But still the it's called the retinitis pigmentosa because when doctors looked into the eyes of someone with this disease, they basically I think, I think the

- name came from that. Okay, so it caused all the pigments.

- Yeah, they there's like, it's a shame that I didn't bring photos. No, it's okay. I will search about it later. Yeah, yeah. So actually, I go also the yearly to the doctor, like in two weeks or something, I go again, and they basically look into my eyes and take photos. So you can actually see the pigments getting, like, there's a lot of dots. And you can see it getting more adults. Yeah, so

- that's basically the blind spots on the rutina. And he's getting Yeah,

- you could see like, David's still the pigment doesn't have to do with how much cells are still alive. So it's it's a bit weird that Yeah. Yeah, it's very, very scientific. But basically, it's getting worse indeed. And more pigment means worse. Site. Yeah, and basically what retinitis pigmentosa contain, yeah, what it represents is I basically have the photoreceptors that die out. So we have cones and rods. Cones are for color rods or for equity and light light sensitivity. So basically the colors and gets less. And it also starts at the peripheral vision. So it goes from outside to the inside. But basically my color side is a bit it's just not the same as for normal people because contrast is like low contrast, it's hard for me to distinguish things with low contrast. So like light blue and light green and to request basically the same color. Yeah, dark, dark blue, dark, green, purple are also all the same. But it's like it's not colorblindness with it's just

- yeah, I understand because the absence of contrast exactly. I can see that because we work a lot with colors and blending colors to make for our design. I know that it's the matter of not the saturation but how much white or black is in that color. So if it's too similar in doesn't matter which hue it is. Yeah, it becomes similar for you. So it's not colorblind.

- Yes, exactly. That's the best way to describe it. And then yeah, so colorblindness is one and then because I it starts dying out of the cell starts at the peripheral vision I'm basically also gives tunnel vision. So I can see my hands right now if I look right in front of me. And it's like it's hair during becoming visible for me. So basically, normal people have like 180 degrees of vision. I have like, a

lot less, but it's still big for me because I'm quite lucky in how much it is going down for me, like there's a lot of people that have during the puberty, it goes actually pretty hard with a DD with dying out of the cells. Basically, for me, it's stagnated. It's still stagnating. So that can take a while. But eventually it should, I should become blind. But that can be around my 30s. But it can also be around 25. Even it can go down in like two years.

- Okay. Also, you cannot predict how fast is going to go Yeah, could suddenly change because

- it's in your genes. And every person is different. They can't really predict anything. They can only say yeah, with puberty. Normally it goes down faster because of more. Becoming a taller person. Basically, there was something about that. Yeah.

- Your body changes faster.

- Yeah, exactly.

- So did you remember what was the first age that you were diagnosed with it?

- So I actually have it since I was born. But they didn't know that. Yeah. Because basically, it's not really that obvious. But when I was little, like around four or five, basically what what what situations my mother found me in was, I had like this Nintendo DS, and it was black. But also, we had not that much light in our house, we had a pretty dark house. So and I need a lot of light, because if I don't have light, I can see. So basically, I put my Nintendo DS on the table. And like 30 seconds after I tried to find my the ESP and I can find it. So I'm touching the floor and stuff. And my mom was just looking at, like, one What the hell are you doing? Because I was touching hair. And yesterday I was there. So basically, that's the moment she thought, yeah, something is wrong. But they couldn't really Yeah, she she just started Googling and finding things about fishing. And she basically she also works at a hospital. So she she is she has a medical background. They, she basically found this retinitis pigmentosa and then she she thought like maybe it could be this. So then I went for a blood sample test, basically. And they looked at my jeans and yeah, they come they found rating it's pigmentosa. And since then I did a lot of like a lot of checks every year, I do a check to see how how, how, how, what my situation is right now. Basically, the tests contain a test about how big my field of view is. And they also test the fishing equity. That that is the right word. I'm not sure.

- Quality means

- it should be like sharpness.

- Okay, yeah. Sharpness, like how far blurry or sharp? Yeah, okay, okay. I don't know the word but I ca understand. Yeah,

- it's something with a cube.

- I don't know. The quality. Yeah,

- facial facial quality. But basically, the facial quality test is, is a bit hard to do because the thing is for raising these pigmentosa, the core of your patient is where the most of your photoreceptors are and the core of my like the center of my sight is very sharp, very sharp. So basically, I can do a lot with the little part that is basically short. So sometimes when I do the test with reading the letters and stuff, I actually get like four four See how good I can see I get like 110%. That's basically because I can also really cheat those because the letters are easy to guess, basically, because I can see like the blob is in this kind of potato shaped so it should be an E or an R or something. Yeah, it's really. So that's rare with advantages

- of being smart.

- Yeah, yeah. So yeah, there's also another test that I do, like I did twice in my life. And that is, then they test they put you in a dark

room. And basically, they turn on the light a little bit at a time. In lumens, they measure it, and they measure per 50 or 100 lumens. And they go up every time. And then I have to describe what I see. And in the dark room, there's like, strange objects. And basically, it's like a living room. But there's like all these objects on the ground. And sometimes they're really strange painting or something. So it's pretty hard to get out of your own. So that makes it pretty fun. Also, it was a really fun experience. Very nice.

- So Aveda, with the darkness, is it also developing as you age that? So maybe in when you were younger? Darkness wasn't an issue that much, but it's get harder?

- For me, darkness was already pretty hard when I was young. Also the I don't know if it I think it has decreased something. But it's really hard to notice. Yeah, how much it decreases since per day. It's such a small increment that I really can't tell the difference. So it's like when you see your nephew, every day, he grows then you don't notice it. When you see him for like half a year, not like you see him again in half a year, then you notice that these like 20 centimeters bigger or something? Yeah, like that's, that's the thing. Like, I can't really notice myself. Except when there's things like looking outside, like when I'm asleep, or when I'm going to sleep. I have a window at my room. And basically, there's this part of the window that's always open. So I always look outside to the sky. Like on some days I like normally I could always see the sky, for instance. But at some days, it's worse other days. It's better that sometimes I can really distinguish the room walls from the outside because it's all dark for me. Yeah. Yeah, so maybe some context like I live in South Holland, just just like at the coast here. And there's a lot of greenhouses, so a lot of orange light the dice on this guy. So normally for a lot of people, it's pretty obvious and they can see outside the window, but sometimes for me, it's not.

- Okay, so that's not enough. Yeah. And

- that's what I noticed, like half year ago or a year ago, like there's like these things that I normally do, then you only notice it for small things that that then don't work out anymore or something. It's not that I noticed a lot of difference

- I can imagine. Yeah, I can relate when when the first I understood that my I need to wear glasses was that I was looking at the sky and I see that the moon is there are two moons in the sky. They see. Yeah, that's when it was first like a shadow of the moon. But the more it got worse. It was like more distinguished movies. And I could see that I need that.

- Yeah, yeah, it needs glasses.

- Yeah, of course. Yeah. So um, interesting. So when you started your school, you already knew that you have you have to maybe have a specific situation around you

- to study my recommendations and stuff. Basically, when I started with priests like preschool or elementary school ground school. Yeah, yeah, basically even from that age, I already got like my own table, specialized table that could go up like a drawing table. So that I could read very close to the paper.

- Yeah. And also your vision, like it's in front of your eyes.

- Also, all my workbooks and notebooks and stuff, they all got printed into a 3d format, so that I could read it because it was all enlarged. Because at that time I didn't the iPads weren't really a thing, then yeah. So now I use the iPad. And that's really nice, because then you can just enlarge everything. Yeah, that's, that's awesome. But I that wasn't there when I was in grad school. So basically, I did a lot of struggling with big pages, because I was really small, and they're really

- big. I can imagine a three is as big as a child.

- And I was I was really small. So it wasn't really that convenient that I made it work. And yeah, at the ground school, there isn't that much that's to do and stuff that reading, of course, you have to speed reading stuff we need to need it to do in high school, or in preschool or ground school. And I basically got, like, double the time of the rest. And I still was the slowest like I, like there wasn't this word list, and you needed to go to 60 words or something. And some people could do that in 30 seconds. I thought the one minute, and I still didn't get to district 16. So that was really, that was the thing where you really noticed that I really needed the extra time and stuff. Yeah. Yeah, in high school, for basically all the languages. I struggled with making homework for that kind of stuff, because languages aren't really my best. My best subjects, that basically also because of my disability, and because I needed a lot of extra time it made it only worse. But still, I managed to do it. Because reading tests, I was really good at them. Took a lot of time.

- Yeah, only you need extra time. And may ask that. Did you ever use screen readers when you were at preschool? Or did you what kind of extra devices did you use to help you

- so at ground school because there were no iPads? Actually really enlargement software or laptops that I could use? We have like, I don't know how you call it in English, actually. But basically, it's this table with a camera on top of it. I think you may know it. Research. Yeah. And then you lay your book or anything like I read the Donald Duck with it. That basically I lay it lay that under the camera, and then there's this screen. Is that what a screen reader is? No, no, that's

- something else. So you use that to enlarge? Yes,

- basically, the camera just makes video and I could actually put it in negatives also. And basically, I could see on the screen and I'll enlarge stuff from it. But there was only in the time when the iPad wasn't there. Because when the iPad came and enlargement software, that's 10 times more efficient.

- Exactly. I mean stuff much faster, much faster. Yeah.

- So in grad school, I use it for the Donald Ducks. But then I got an iPad in high school. And in high school with the iPad, you can just download an app and you have all the download docs and you can actually enlarge on the screen already. So it became from this big, huge thing with a camera to just an iPad with where you can just enlarge it's really nice.

- And well the screen readers are the ones that read the screen for you invoice. Have you ever tried it?

- I had some text as it's called for. I think that's one of the most main programs that's used by visually impaired people. ZoomText works it works really great. When basically in during the first three years of high school I use it a lot not till even the last three also but it's sick Here's a high school for us. It's the same. Basically, after the first three years, ZoomText got a pretty good competitor, because the magnifying software from Windows itself is also really great. It was really competing with some text, for me at least, that after high school, I chose to use the magnifying software because it's already standard in every Windows record areas. Yeah. And ZoomText itself is really expensive. And made it Yeah. not that attractive. Because also ZoomText and Windows didn't work that great together. So the software really makes your laptop really slow. It wasn't just not 100% compatible well, to magnifying software is literally in the Windows software. So

- And was it also the reason that the magnifier allows you to read whatever you want to wear wherever you want in your own speed? Not that someone reads it for you, basically?

Unknown 26:15

Yeah, so I didn't really like people like, like the software reading for me, because I always read slower or faster. And I don't read in one specific tempo, if there's a hard if there's a difficult word somewhere, you stop for a minute or something, or I don't know. So basically, I always kept the reading software off, but I used some Desi spinners. The C player, I don't know how you call it in English, but it basically audiobooks. Yeah. So at the beginning, I had one where you had to put in a CD, then it becomes some sort of became some sort of mp3 speaker. mp3 player. Yeah.

- Okay. So but for your studies, you prefer to read it yourself? Of course I can. I can imagine that. Some parts are harder, you need to go through it you need your time to comprehend learning

- is also very important that visual and actually that you're actually doing it yourself because audible was nice. Yeah, but it, it just goes into your air at one side and goes our daughter. Only hearing it doesn't make it stick.

- Yeah. Oh, that's interesting. So would you would you say that you have more visual memory that than hearing memory? Because some people learn easier by hearing others? If they see something that that sticks to their mind?

- I'm I'm probably I think a lot in like I don't know how you call it in English with like, I think in images like, yeah, I can see every single Yeah, I visualize a lot. Yeah. So what makes me also great in thinking of designs and stuff for my study, but it's sometimes also annoying. That, yeah, like Audible isn't really preferred for me. I can say that it doesn't work. But I prefer visual and actually seeing it yourself and reading it yourself. Because when you read it yourself, you're actually also engaged in the subject. And you're thinking about it. Well, if you only heard through audio, I would get bored, very fast, and just get distracted.

- Distraction. But yeah, so I can just understand, then, how did you experience doing the homeworks, for example, or the assignments at university? Because sometimes you need to type them or how did you manage those stuff?

- So let's begin first a little bit about high school, like on a high school, everything was pretty easy for me. I didn't do that much homework. I got a lot of good grades by not doing that much. But then University came and I knew I had to do more than I did in high school. But it actually was a lot more. The tempo at Aerospace is incredibly high and they say it's like 42 hours a week or something you can make it's maybe 42 hours a week. If you only come the lectures we get and traveling, I have to do the next to that I need to make a lot of homework. So basically 5055 hours a week, I think I'm on. And that makes Yeah, because I already do read, like very slow. It's also that when I do my homework, I can't really make all of the homework. I basically select, like, if there's like six recommended exercises, I make three or four maybe. And then I have to be really efficient at making homework. Since I just don't really have the time to do everything. It's just it's not possible to actually make all the homework, even if I wanted.

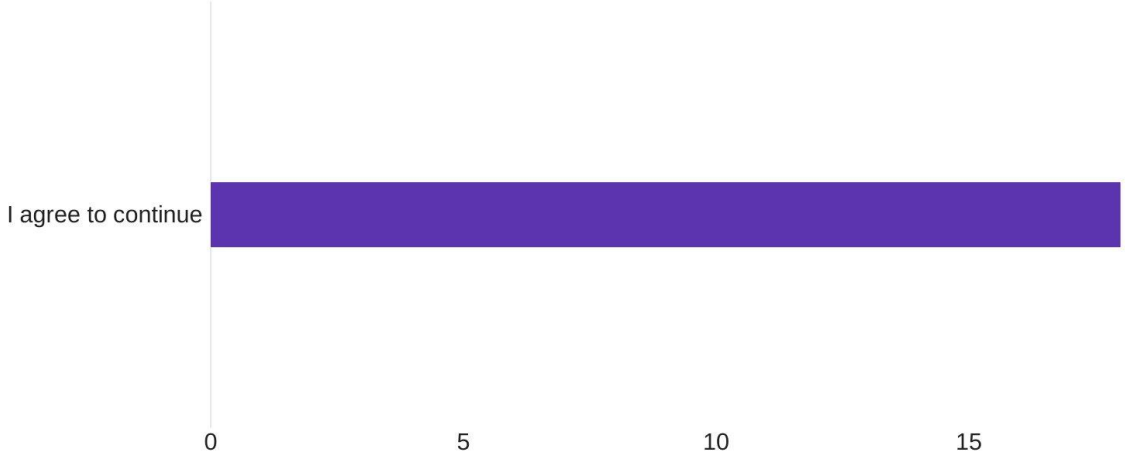
Appendix C - Survey Q&A Overall Analysis

1

18 Responses

Consent	Responses
Hi! My name is Rojin. For my master's thesis at Delft University, I am reaching out to higher education students with visual impairments to better understand their challenges and experiences. I am well aware of the particular challenges and barriers you experience in gaining access to school and other opportunities, and I am eager to address them in my master's thesis. I did my best to tailor this survey to the needs of the visually impaired in order to provide valuable insights and statistics while also raising awareness and facilitating a more inclusive society. By taking part in this survey, you will be making a significant contribution to improving the lives of people with visual impairments. I would appreciate it if you could take the time to complete this survey and share your thoughts and experiences. Your contribution is critical in shaping a more inclusive and accessible future for all. There are a total number of 13 questions that you may skip any of them if it feels uncomfotable. Thank you in advance for your time and consideration.	18

18 Responses

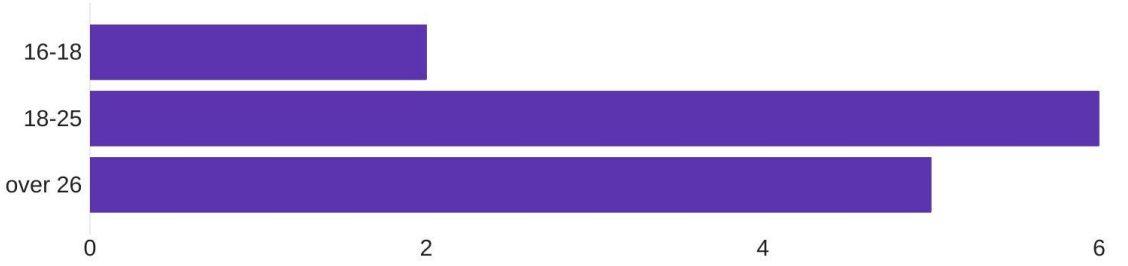


18 Responses

Field	Choice Count	
I agree to continue	100.00%	18
Total		18

Q1 - How old are you?

13 Responses



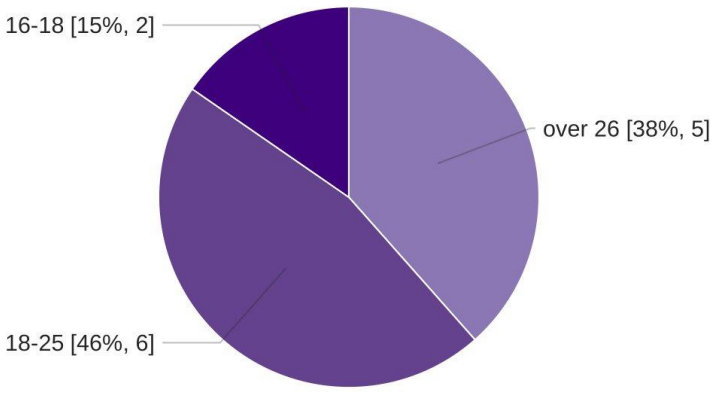
13 Responses

Field	Min	Max	Mean	Standard Deviation	Variance	Responses
How old are you?	1.00	3.00	2.23	0.70	0.49	13

13 Responses

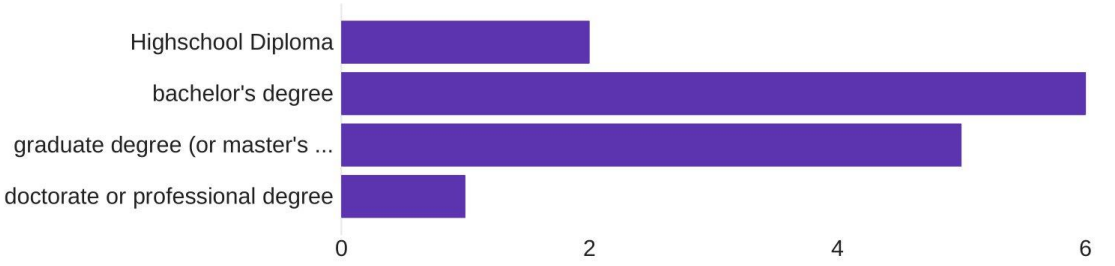
Field		Choice Count
16-18	15.38%	2
18-25	46.15%	6
over 26	38.46%	5
Total		13

13 Responses



Q2 - What level of education are currently you pursuing?

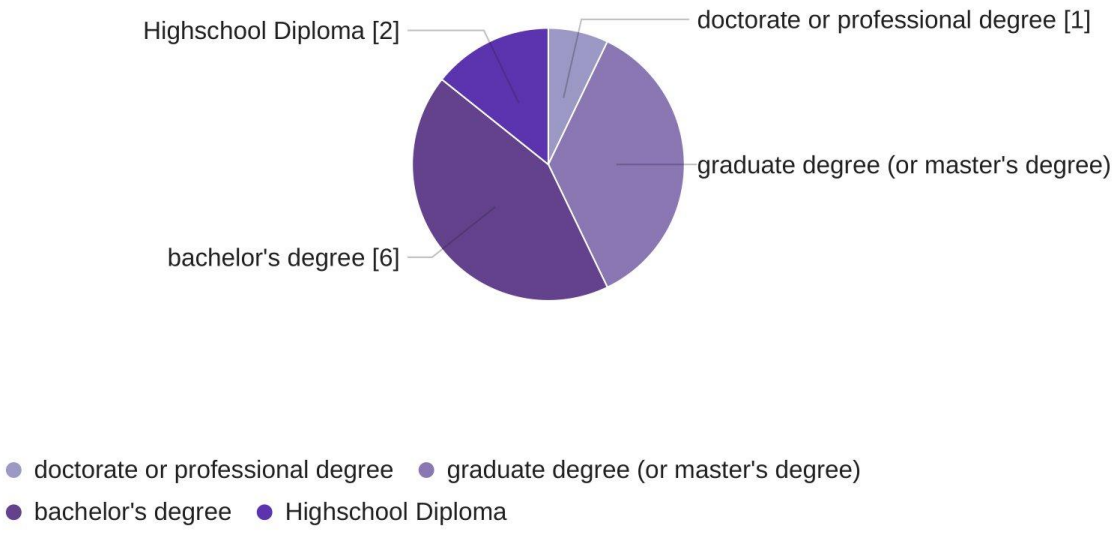
14 Responses



14 Responses

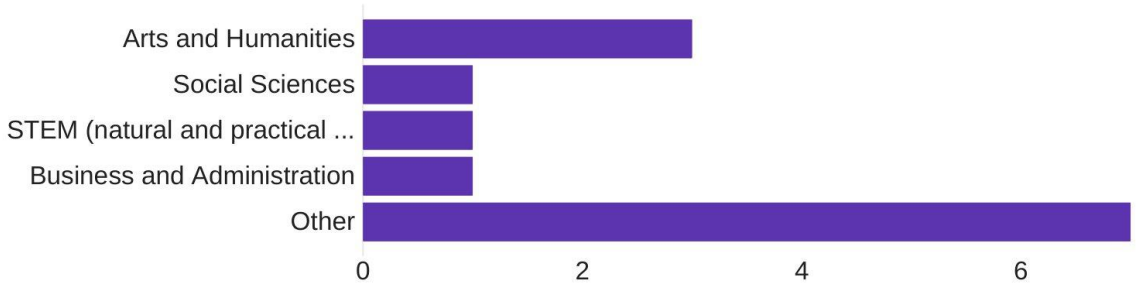
Field	Choice Count	
Highschool Diploma	14.29%	2
bachelor's degree	42.86%	6
graduate degree (or master's degree)	35.71%	5
doctorate or professional degree	7.14%	1
Total		14

14 Responses



Q3 - What category of program you are pursuing?

13 Responses



13 Responses

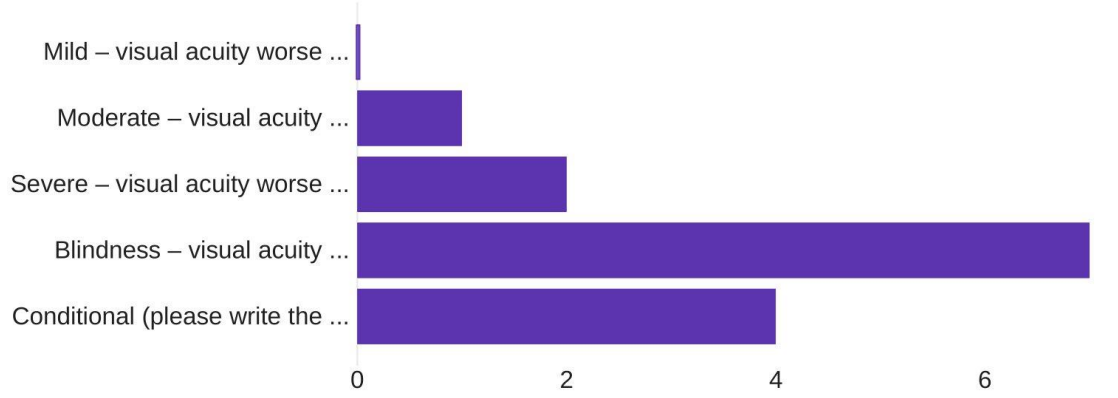
Field	Choice Count	
Arts and Humanities	23.08%	3
Social Sciences	7.69%	1
STEM (natural and practical science, technology, engineering, mathematics)	7.69%	1
Business and Administration	7.69%	1
Other	53.85%	7
Total		13

7 Responses

Other - Text
Education
Digital Retail and music
Child devolpment
Law
sociology
Hospitality

Q4 - How do you define the level of your vision impairment from the following choices?

14 Responses



14 Responses

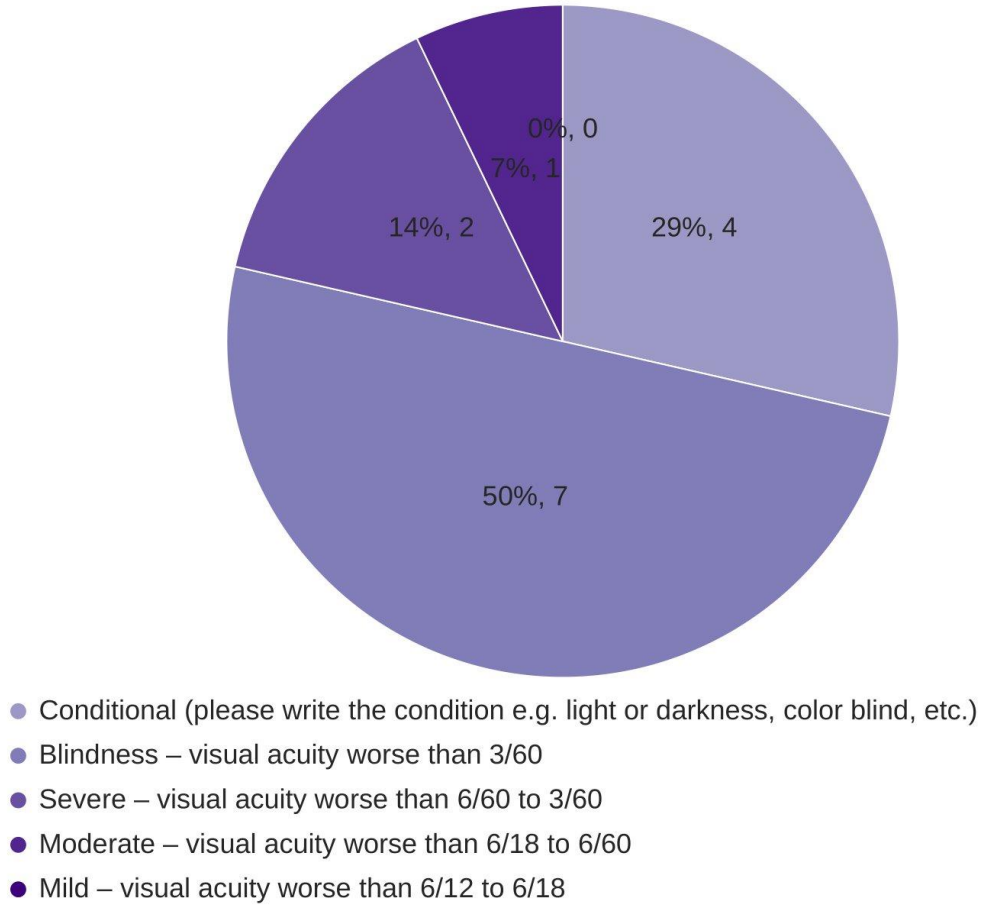
Field		Choice Count
Mild – visual acuity worse than 6/12 to 6/18	0.00%	0
Moderate – visual acuity worse than 6/18 to 6/60	7.14%	1
Severe – visual acuity worse than 6/60 to 3/60	14.29%	2
Blindness – visual acuity worse than 3/60	50.00%	7
Conditional (please write the condition e.g. light or darkness, color blind, etc.)	28.57%	4
Total		14

14 Responses

Field	Min	Max	Mean	Standard Deviation	Variance	Responses
How do you define the level of your vision impairment from the folloing choices? - Selected Choice	2.00	5.00	4.00	0.85	0.71	14

6

14 Responses



4 Responses

Conditional (please write the condition e.g. light or darkness, color blind, etc.) - Text
Darkness
Right-side hemianopsia (missing half my vision in both eyes)
Retenopothy of prematurity
Blind

Q5

8 Responses

What kind of accommodations, if any, have you found to be helpful in overcoming the challenges associated with your visual impairment?

Extra time for exams, a reader for exams, note takers, text to speech software (Kurzweil or JAWS)

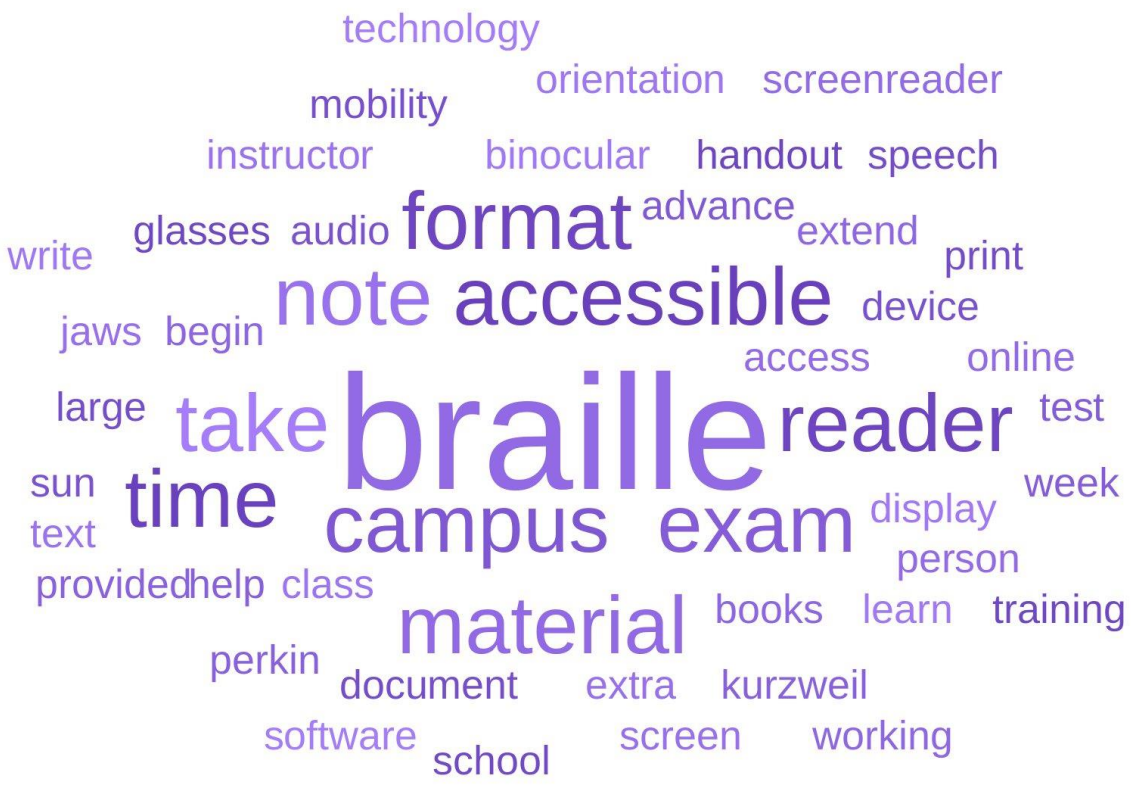
Technology devices with screen readers, braille, having Someone writes for me whether it's a note, taker, or a person who helped me with test

Having brailled materials, extended time on exams, working with an orientation and mobility instructor around campus a few weeks before classes begin.

Sun glasses, binocular

Screenreader, Braille display, handouts and books provided in an accessible format in advance. Also O & M training so I can learn how to get around campus.

8 Responses



Q6

8 Responses

How has your visual impairment affected your ability to access education and other opportunities?

I don’t have access to any books that aren’t in audio or haven’t been scanned digitally. On another level, I get the sense that colleges see my disability as something that will cost them extra money. I applied to 10 graduate schools over 3 years and only got into 1 (not even my almamater accepted me). I have a 4.0 GPA, and have won awards for my art, but my practice and perspective is tied to my blind experience and I can’t help but wonder if that cost me opportunities.

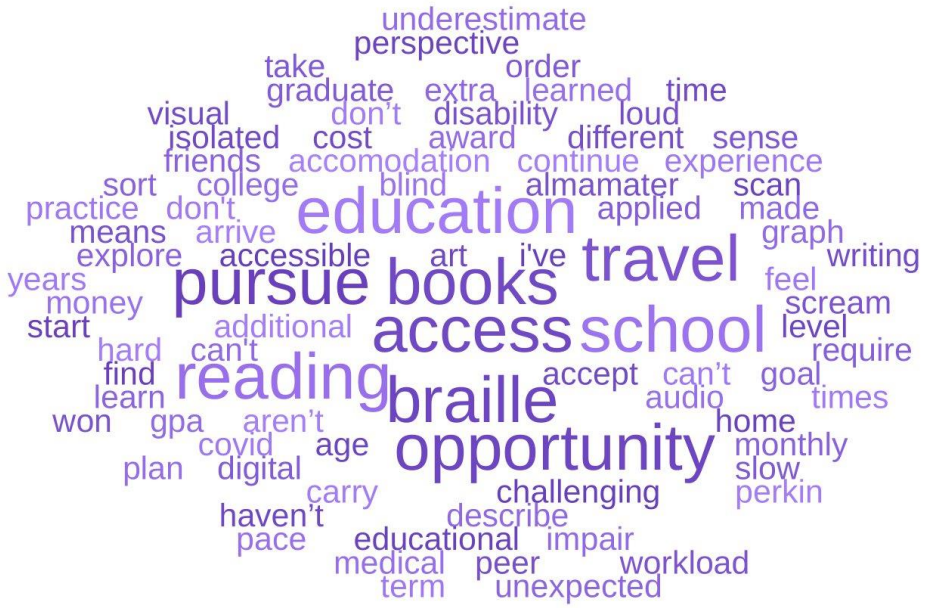
It causes me to explore me for accomodations. Also allows me to learn differently and slow pace

It has made me feel isolated from my peers. Also, I am usually underestimated regarding certain educational opportunities because it is unexpected that someone with a visual impairment is still able to carry the workload or pursue such goals. Access to an education is definitely harder than it is for some of my peers because at times, I feel as though I have to scream so much louder in order to get what I need.

I can't pursue medical

It's challenging to find new friends because any sort of travel takes additional planning. If books don't arrive on time, I've had books arrive for a term at the end of the term, it means I cannot do required reading.

8 Responses



Q7

7 Responses

Have you encountered any technologies or assistive devices that have been particularly helpful in managing studying with your specific condition? If so, please describe them.

Kurzweil, JAWS, Daisy Reader, projectors (for drawing)

Jaws zcreen readers

Not particularly. During college, I used the BrailleNote Apex and the BrailleSense Pollaris. Both of these devices are notetakers which assisted me during lectures, as well as at home when completing assignments such as discussion boards and papers. I also used them quite often to access textbooks, and books I had downloaded to read on my own downtime. My iPhone and iPad also came in quite handy, and still do.

Screenreaders, Braille displays.

Yes I've used a computer with screenreading software that make the computer have sppech. Also I use a braille notetaker that allows me to read information in braille and also I take notes.

7 Responses

Q8

8 Responses

When entering a new building at the school, how do you find and navigate to a certain room that you want to go to? Can you describe all the thinking process and feelings when you do so?

I ask for a tour or scope out where my classes are prior to every school semester

I feel around with my cane and hands. I walk the route a few times. I get a bit nervous i will run into things and break it.

I use my cane and have to think very hard about where I am. This can be very difficult because there are always people around, and I am an overthinker who can get anxious quickly. I try to move to the left or right of the building, and recall any landmarks that will indicate where the room is located, since there are so many. If everything becomes too overwhelming, I will eventually ask for help. I am not above that, especially if I am running late.

Anxiety, stress

First, I would ideally have already had training to learn the route to this room, if not, I can interpolate by using the information I have already learnt about rooms in this building, so if I know where w27 is and I have to go to w29, I know it's near w27, so I will head there, and then work it out or ask someone if there is someone around.

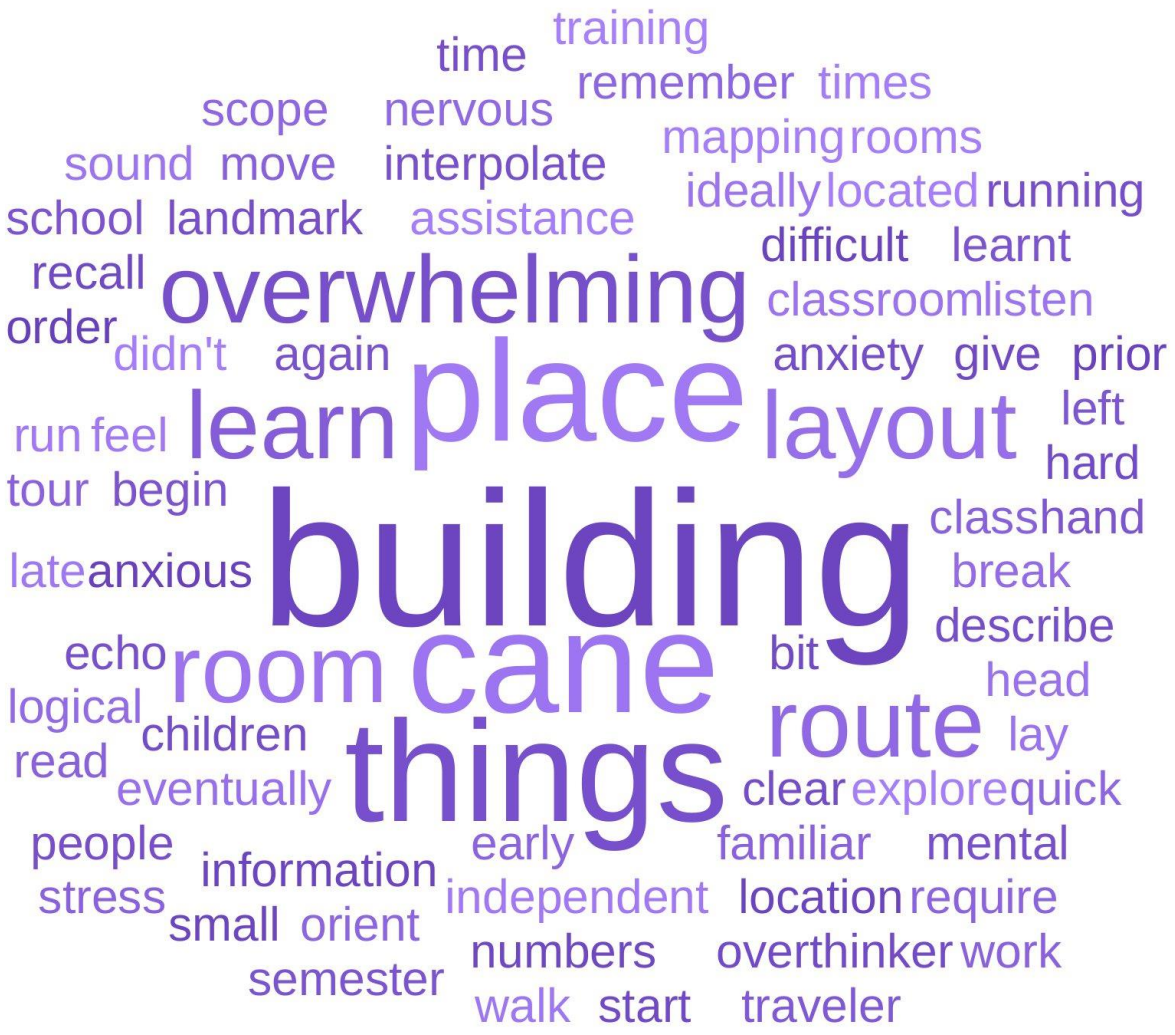
I go to the new building with someone and they describe the layout of the place. Then I start to learn the lay out little by little.

Most buildings have a clear layout and are in logical order with classroom numbers. I sometimes would ask but it is overwhelming when going to a new place because I have to remember small things if I ever have to go there again

We take our son early so he can orient and explore on his own before things begin. He uses mental mapping and echo location. He listens for familiar sounds. He requires assistance in new places for a time. He is not an independent traveler. He is 16 and when he was two they didn't believe in giving children canes, so we read and got our own and got him started.

11

8 Responses



Q9

7 Responses

When you are learning or studying about a topic that includes charts, infographics, or any kind of visual esplanation, how do you percieve the overview of that visual data? and what is the main issue in understanding that information overview?

I ask for help

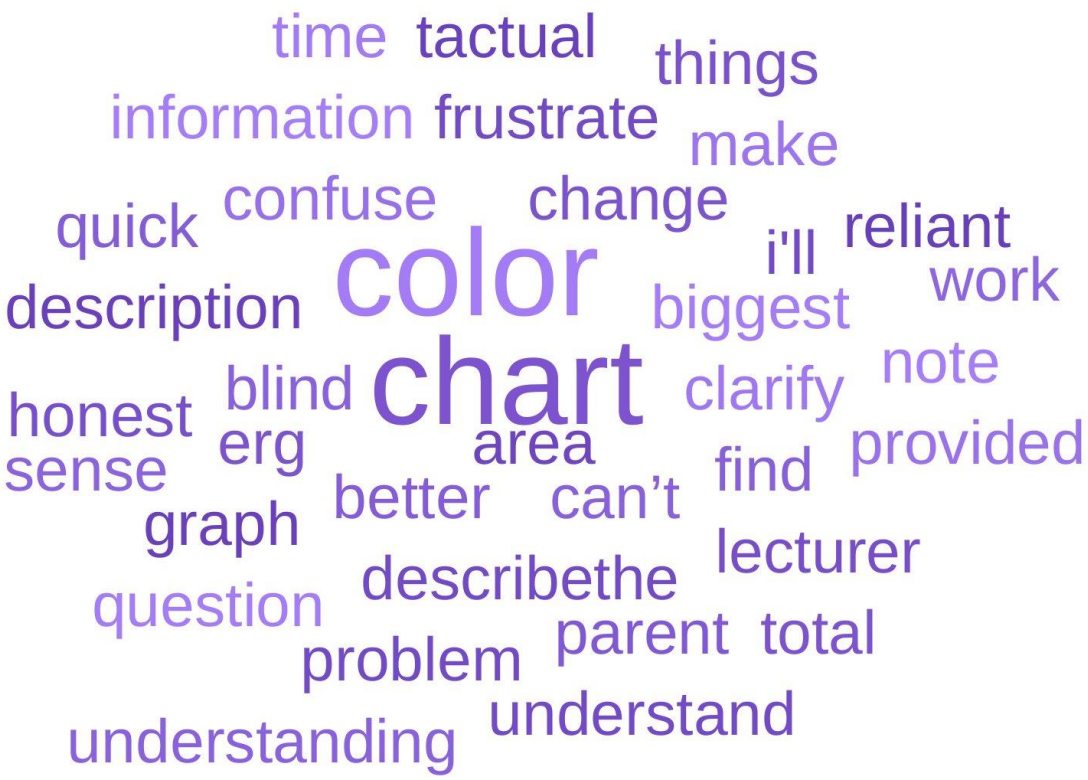
To be quite honest, things get very confusing for me in that area. Perhaps it is because I try to take it all in and understand everything at once. I am not sure, but I find myself becoming frustrated very quickly.

Color blind, take help of parents

I try to make sense of the description provided to me by the lecturer, if that doesnt work, I'll ask questions to clarify my understanding.

I have someone describethe charts. Also I take notes on what the graph has on it.

7 Responses



Q10

8 Responses

How do you think higher education could be made more inclusive and accessible for individuals with visual impairments?

If assistive devices were more mainstream and could be accessed by both disabled and non-disabled people, I believe it could open the doors for understanding, inclusion, and innovation. I'm a visual artist and comics creator with limited experience with technology, but I recently worked with an English professor and a person in the tech lab at Wichita State to create an app for accessible comics. Our team recently won an Accessible Comics award sponsored by professor Nick Sousanis of San Francisco State University.

Brighter lights, more contrast in the building

Higher education should require that instructors at least have some sort of awareness of how to accommodate a blind or visually impaired student. These accommodations are not mind boggling, but I have encountered many a professor who has still never heard of Disabled Student Services because they have never instructed or taught a blind or visually impaired student before. Before each semester, the campus website should constantly be checked and updated for any accessibility issues, as it is a constant problem that students are unable to access content from their portals due to these glitches. I often hear about a lack of awareness about guide dogs on campus. Perhaps we can find, a way, I do not know how yet, to share some of the main things guide dog users would like to express to peers and emploers in the offices on campuses as well.

Making visually impare gadgets cheaper

Better sight loss awareness training for staff, visiting lecturers and students.

8 Responses

Q11 - I would like to ask you to record a short video that demonstrats your surroundings at school in a usual class or place that you study. It may contain your belongings, desks, boards, and whatever you might have around you as usual. Please skip this question if it is not convenient to send a photo.

No data found - your filters may be too exclusive!

Q12

6 Responses

Have you encountered any barriers or discrimination due to your visual impairment? If so, please provide details.

First Vocational Rehabilitation counselor told me I couldn’t be an artist because of my disability.

I am multi-disabled, and needed someone to be with me during classes. After providing all medical records and speaking with all the higher-ups including Disabled Student Services, the Department of Rehabilitation, Harbor Regional, and even the dean of my school, it was determined that I would eventually have to attend classes with a family member. This family member would wound up being my mother, as no one else could provide those services at the time. I was and still am so greatful for her help, but classmates and even professors would often speak directly to her concerning assignments, as if she were taking classes to receive a degree. Thankfully, she never responded and always gave me the opportunity to speak for myself, knowing I was perfectly capable.

There are no proper schools of visually Empire in India so I was forced to study in normal school and there was other mental handicap girl when we both say together and she used to tell me what is written on the board but that is for few days when she get transfer to other class then it was a big problem I just hear in the class and use digest and reference book for study

barriers include lacm of access to info, such as when my textbooks arrive late in the term.

Transportations can be a challenge so sometimes I may have to miss school because not being able to get a ride.

My son was told he couldn't take his stick (white cane) into a museum. After a short education speech and threatening a civil right complaint, no more issues. We generally try education and sense of humor, but unfortunately strong advocacy skills are required!

6 Responses


together
textbook
visually
providing
require
reference
thankful
student
member
medical
provide
transfer
problem
humor
handicap
time
strong
issue
determined
info
including
receive
record
education
classmate
disability
museum
stick
complaint
attend
challenge
harbor
higher
short
arrive
advocacy
directly
ups
couldn't
cane
late
disabled
told
class
access
digest
ride
need
couldn’t
board
hear
school
india
dean
big
artist
empire
greatful
civil
book
multi
forced
barrier
degree
skill
rehabilitate
miss
capable
family
mental
lacm
proper
counselor
assignment
days
gave
normal
department
sense
professor
concerning
generally
girl
speak
term
knowing
eventually
mother
service
include
taking
perfectly
regional
study
opportunity
respond
threaten
speech
transportation
vocational

Q13

6 Responses

Lastly, are there any additional comments or experiences you would like to share about living with a visual impairment?

Disability is the largest and most fluid minority group, and there’s no good reason why the world Is not more accessible

Although it could be difficult, sometimes it could also be fun to try to figure out ways to do everything in the end result always is much more rewarding. We as Blind people have the opportunity to help the world see the world in a different way.

Been visually imperies very difficult people in the society does not accept us the way we are they do not give us the opportunity if any if you deserve it and somehow family members will also leave us at some point of life and we have to be independent and that is only the case that we cannot be independent even though we want to be jobs are also not there for visually impaired anyone if they are there it is been miss allocated in India I don't find anyone giving a proper Guideline in having a proper career opportunity for visually impare

It can be highly stressful, whenever I leave my house, I expect there to be some sort of interaction with a member of the public that shows general ignorance of sight loss, or to face a challenge like a bus not turning up on time, group meetups being reorganised to different location at the last minute. And being expected to just be calm and not show any sort of frustration or negative emotions as a result, because then I would be that annoying disabled person causing problems for the normal sighted people.

None at the moment.

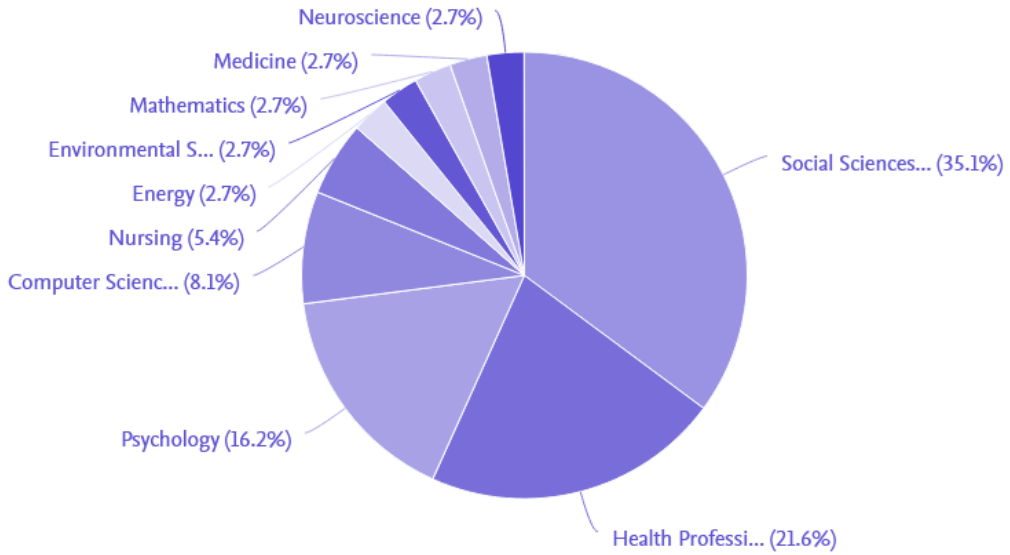
It is generally small children and older children who are afflicted. It is a low incidence disability and the person may look normal, so there is a lack of accommodations. Braille lettering on bathrooms and elevators are out of reach for short people of all ages. We need more marked road crossings, audible crosswalks, better school services in home communities, better transportation in rural areas, medicaid with no barriers, such as income limits. It costs a lot to be disabled and those who want to work are restricted by income guidelines. There are no services or few in rural areas. There are many more.

6 Responses


public road problem restricted
reason
marked loss miss reach
service medicaid
guideline house location minority
minute income
community incidence school
none last elevator cause
crosswalk lettering
largestdeserve opportunity
blind don't
find calm
india
area braille
home person disabled
highly
accessible
emotion
figure normal difficult group age crossing
costs
lot
fun allocate
people world
job result
lack
barrier good
give audible
afflict
accept
bus
low
better leave disability
impair
annoy expect
old
life accommodations
member case generally
ignorance bathroom
fluid limit
guidelines children career challenge
rural
interaction
point impery frustration family
independent
impare look
rewarding moment
meetup negative
proper
reorganise

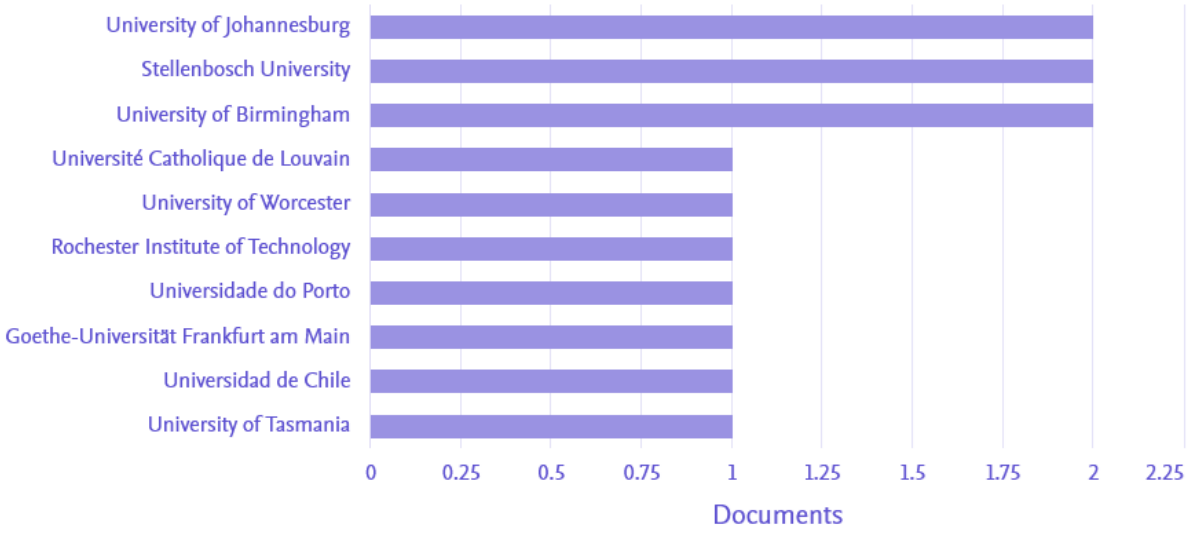
Appendix D - Explorative Literature Analysis

Documents by subject area



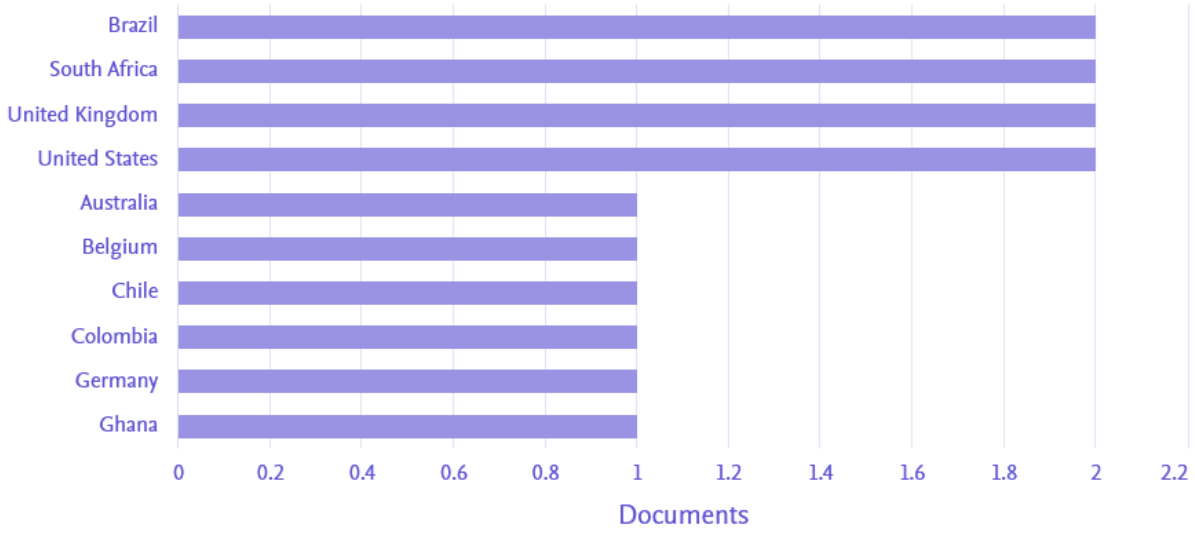
Documents by affiliation

Compare the document counts for up to 15 affiliations.

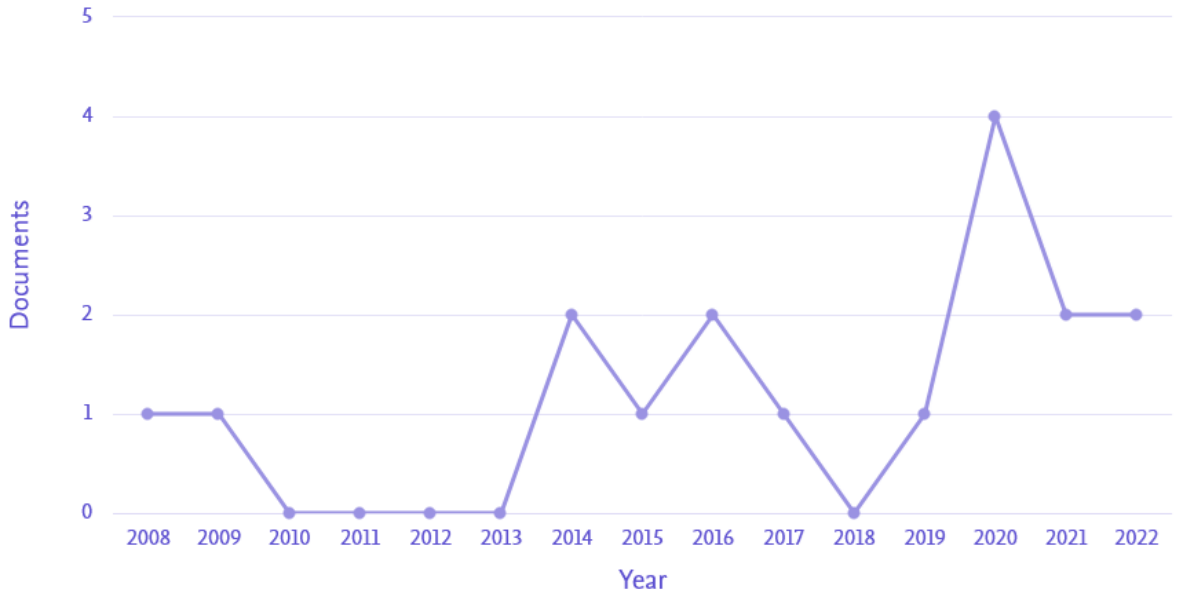


Documents by country or territory

Compare the document counts for up to 15 countries/territories.



Documents by year



D.1 References:

Rustemeier, L., Voß-Nakkour, S., Mateen, S., & Hossain, I. (2021). Creation and Future Development Process of a Serious Game: Raising Awareness of (Visual) Impairments. *Serious Games*, 131–137. https://doi.org/10.1007/978-3-030-88272-3_10

Wie steht es um die digitale Barrierefreiheit an hessischen Hochschulen?

http://innobar.studiumdigitale.uni-frankfurt.de/Umfrageergebnisse/Digitale_Barrierefreiheit_an_hessischen_Hochschulen.pdf
When disability becomes ability to navigate the transition to higher education: a comparison of students with and without disabilities (Dangoisse et al., 2019)

Dangoisse, F., Clercq, M. D., Meenen, F. V., Chartier, L., & Nils, F. (2019, December 26). When disability becomes ability to navigate the transition to higher education: a comparison of students with and without disabilities. *European Journal of Special Needs Education*, *35*(4), 513–528. https://doi.org/10.1080/08856257.2019.1708642

Full inclusion of a student with visual impairment over the full Physical Activity and Sport Sciences Degree: A case study (Reina & Ruiz, 2016)

Reina, R., & Ruiz, J. L. (2016, February 9). Full inclusion of a student with visual impairment over the full Physical Activity and Sport Sciences Degree: A case study. *European Journal of Adapted Physical Activity*, *9*(1), 40–52. https://doi.org/10.5507/euj.2016.004

Development of Accessible Website as support for people with visual discapacity; [Desarrollo de Sitio Web Accesible como apoyo para las personas con discapacidad visual]

Chilean higher education entrance examination for learners who are blind

Teacher education for distance learning based special education in Pakistan

Accessing the curriculum; university based learning experiences of visually impaired physiotherapy students

Developing an inclusive learning environment for students with visual impairment in higher education: progressive mutual accommodation and learner experiences in the United Kingdom

Some practical insights on teaching FL to visually impaired students

Developing inclusive outreach activities for students with visual impairments

Preservice physical educators' self- efficacy beliefs toward inclusion: The impact of coursework and practicum

Experiences of visually impaired students in higher education: bodily perspectives on inclusive education

University Experiences of Graduates with Visual Impairments in Ghana

Reports by blind musicians: Supporting the teaching of music for students with visual impairments; [Relatos de músicos cegos: Subsídios para o ensino de música para alunos com deficiência visual]

Linda Rustemeier, Sarah Voß-Nakkour, Saba Mateen, and Imran Hossain. 2021. Creation and Future Development Process of a Serious Game: Raising Awareness of (Visual) Impairments. In Serious Games: Joint International Conference, JCSG 2021, Virtual Event, January 12–13, 2022, Proceedings. Springer-Verlag, Berlin, Heidelberg, 131–137. https://doi-org.tudelft.idm.oclc.org/10.1007/978-3-030-88272-3_10

Appendix E - Content Inventory and Audit Summary

Florian: blind programmer – Netherlands (2019, March 20)

During the recruiting process, the recruiters had no idea he was blind as a programmer until he had to go there in person. They realized when they saw the white cane. However, if he brings the guide dog, he must notify the recruiting team in advance to avoid any allergic reactions among those present. Then, the HR or recruiter will ask him some additional questions about his situation, and he will explain the obvious responses, and he will assure them that he will bring his accessibility devices.

He minimizes his blindness to the point where the other person does not notice it, allowing him to influence the interview and recruitment process as much as possible without the disability having any negative or positive influence.

He believes that this field of work is accessible to blind people, but it will be difficult because a lot of what they will do is not documented (once you pass the student stage, you don't document things in this field), so people won't be able to find their answers anywhere, making it less accessible to blind people.

There should be a knowledge repository and curriculum, a living document and resource for future blind people who want to go in this field.

Caitlin Hernandez: special education teacher – San Francisco (2019, April 3)

“So, because it took so long to get all that squared away, even though I had already been hired, the first year was just very broken up and not ideal.”

Technology she uses include her laptop with **NVDA screen reader** (it is a free Windows screen reader that is the primary screen reader for 40% of users, also helpful for checking web page accessibility), and **Braille-Note Touch** to read with students and take notes.

Accommodation is not overly complicated; she merely has a **scanner** or **reader** for printed documents. The manager always emails all meeting instructions to her so that she can view them electronically.

“I didn’t have any disabled teachers and I wish that I had… Like a role model.”

“I think it’s great sometimes when people kind of are obviously aware of your blindness and respect it, but also don’t make a huge deal out of it.”

Sean Randal: Technology teacher at New College Worcester for visually impaired (2019, April 17)

He always revealed his blindness on application forms and cover letters because he had a fear of going into an interview and being given something to read or write. If that happened, he believes he is responsible for not saying what he wants; if adjustments are required, allow firms time to make them. Being open about his blindness is vital, he believes, even when he has had multiple applications rejected because a sighted candidate was preferred over him.

Angela Fowler: Business Owner (selling a homemade product) (2019, May 15)

She argues that blind people face stigma and difficulty finding their first jobs. As a result, she wants to hire them in order to provide them with the necessary experience.

Matthew Horspool: Braille Transcriber (2019, May 29)

The SEB standard braille code was established in English-speaking nations in 2004. Nowadays, all transcribing apps, such as Word, are available. Transcription is similar to editing. Before you can master braille, you must first think like a blind person. A table can only have 4-5 columns for a blind person, while a 5-column table is nothing for a sighted person. So, you must know that the ways sighted, and blind people solve problems differ greatly.

When transcribing, there are some elements you should know in a text since you must decide whether something is important or not, such as if something is written in bold. You don't want to read over its word for word and character for character to see if each letter is bolded because that takes too long.

Because the speech and sound manager is crucial, the emphasis of the voice illustrates the bolded, underlined, italicized, colored, and highlighted phrases; so when the speech switches to the emphasis voice, a blind person knows they need to pay more attention to this portion of the text. You could also have different voices for bold, underline, and so on, but it makes it difficult to keep track of the distinctions.

Justin Yarbrough: Digital Accessibility Specialist (2019, December 23)

Accessibility is necessary for online classes as well as online meetings. In order to accomplish this, they adhere to the WCIG requirements for the accessibility check.

The adaptation he need for his job is a laptop in place of a screen so that he can carry it to the meetings as well. Additionally, the arrangement in his office and at the table would need to be modified because his guide dog requires some space.

Martin Ralfe: Technology Services and Skills Lead (2020, January 8)

The combination of technology and a guide dog is the recipe for independence; a good service can strengthen the bond between these two. Guide dog training has been going on for a long time, but technology needs to be focused on more.

They train one person of staff per community with guide dogs; that member should comprehend sight loss as well as technology, allowing talks to take place and information to be passed on.

During the recruitment process for his job, he did not initially get the position, but because the person who interviewed him liked him, they offered him a three-month traineeship. During this traineeship, he learned how the systems work and became acquainted with technical support and guide dogs, among other things.

It is more important to listen to customer feedback than to base the service on one blind person who works in the team, because customer service interacts with approximately 200 people per month, and people differ. One person's opinion is not representative of the rest of the world. However, one person's opinion is still important.

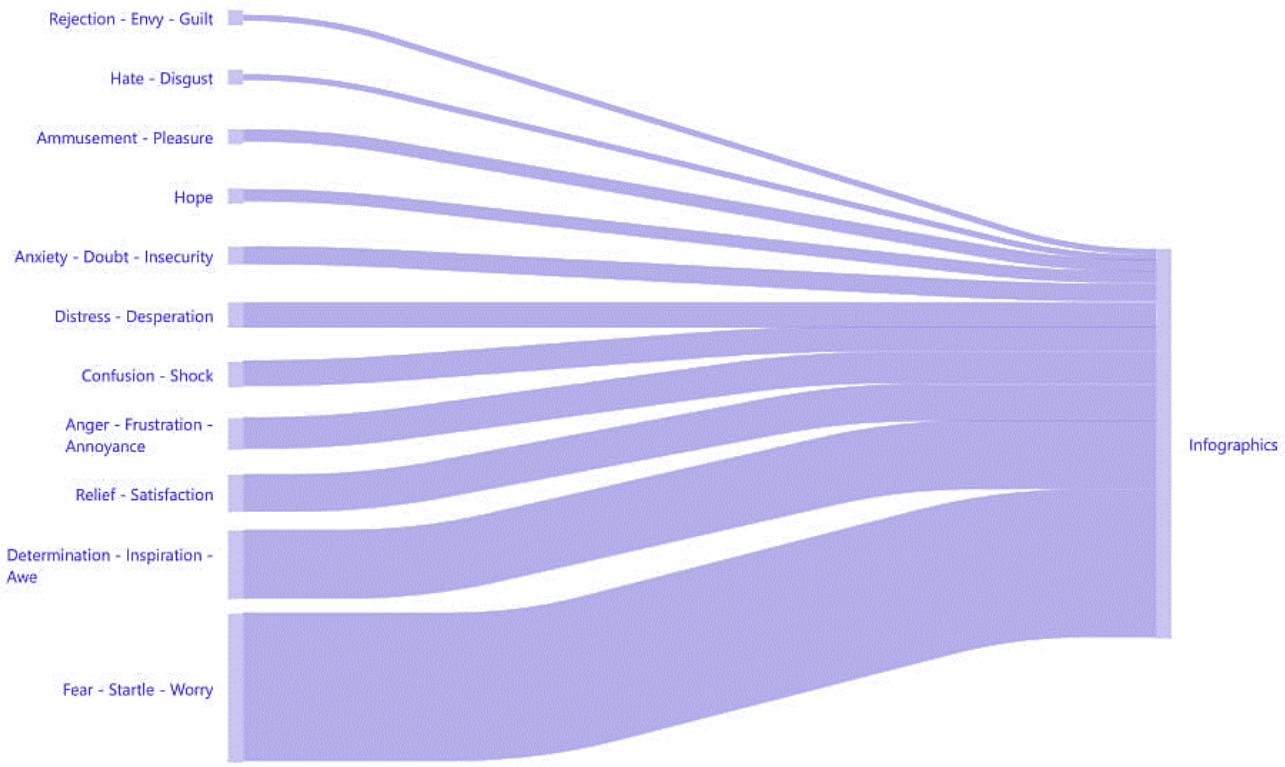
Lawrence Brown: Blind Musician (2020, October 31)

Hardware is also a challenge for blind people because you don't know how to plug in for some systems, such as setting up the microphone and speaker for recording music, unless someone

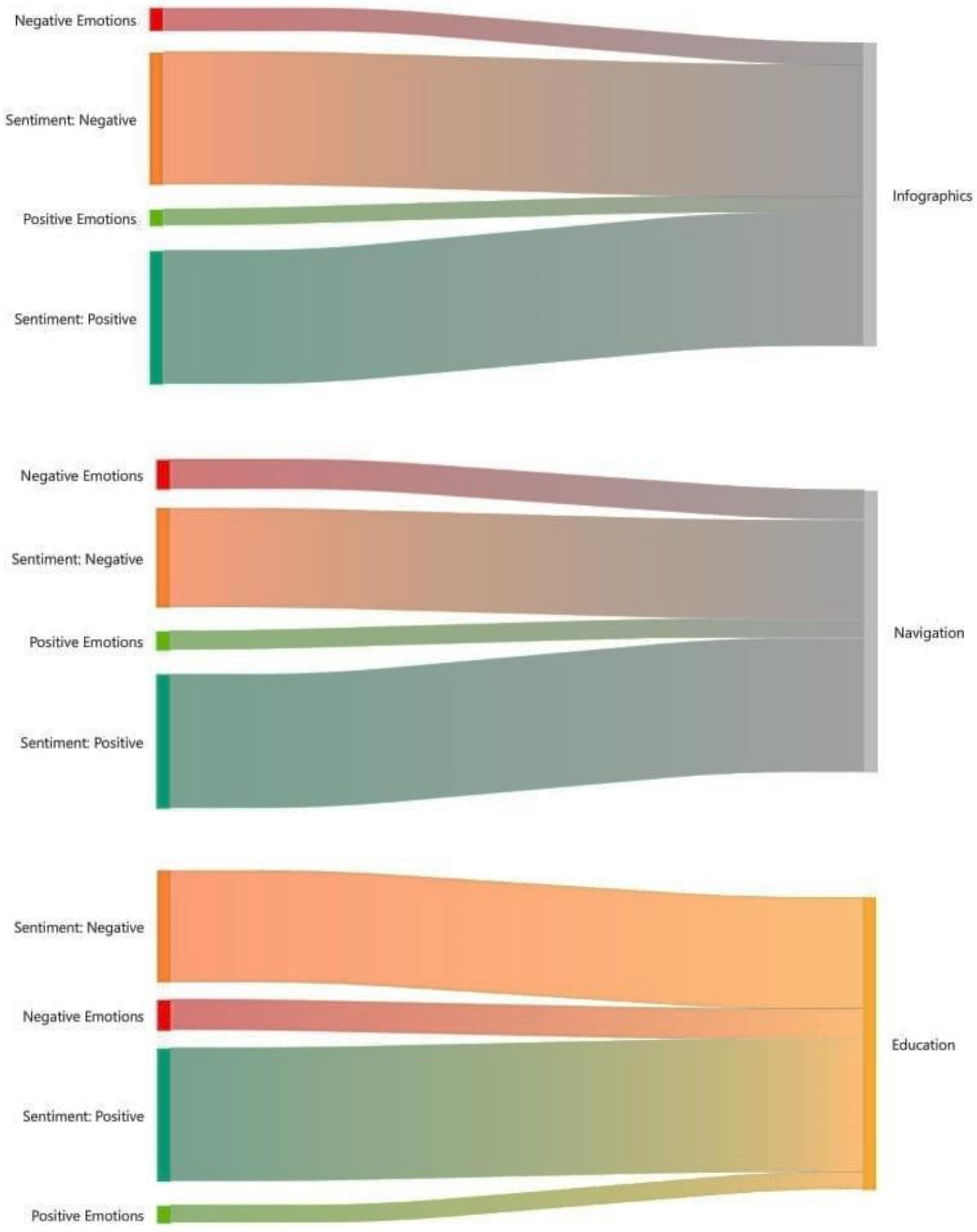
Appendix F - Secondary Literature Data Analysis on Correlation of Values and Experiences

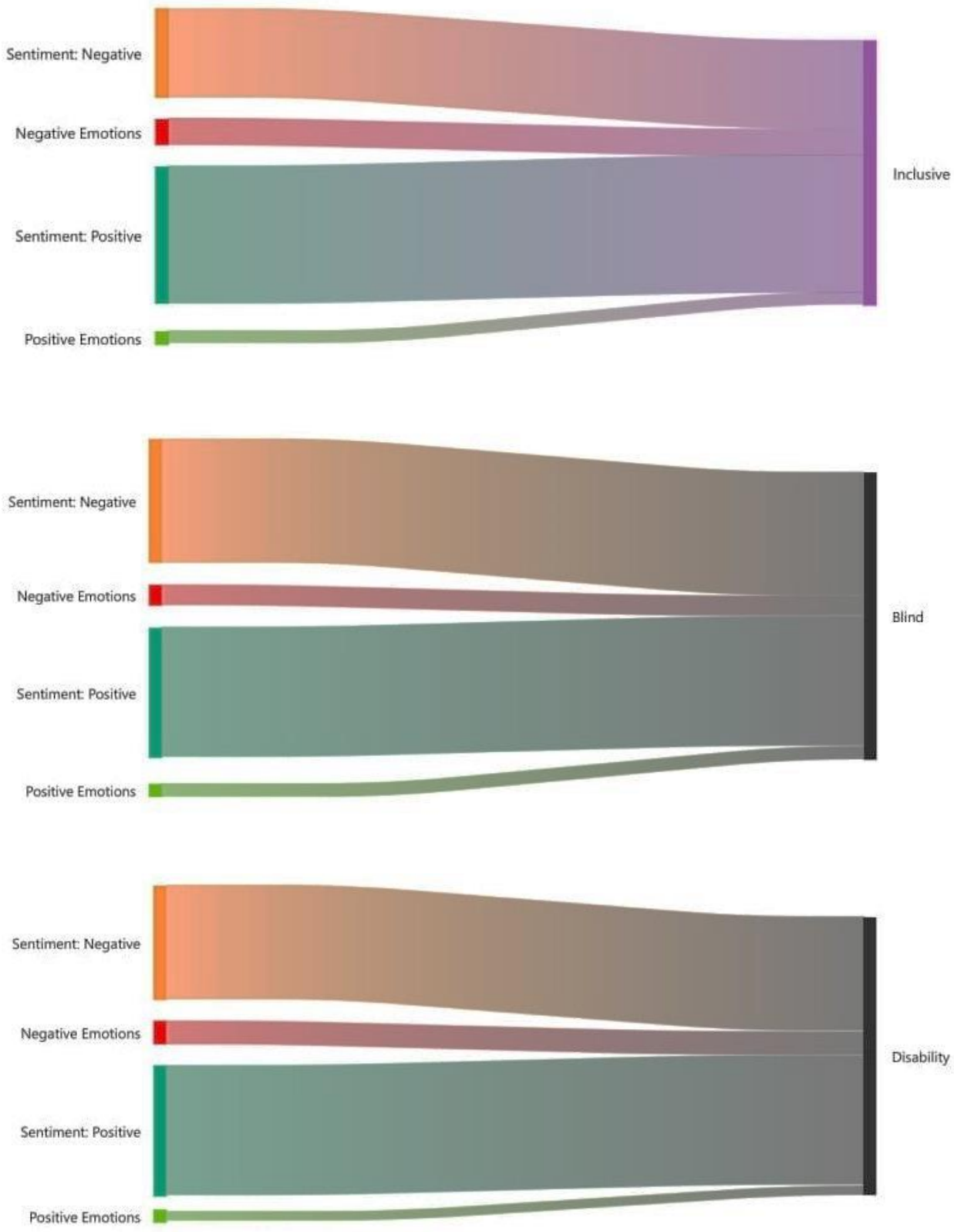

training low staff age years
although within well often organisation inclusive
less mental say human e.g methods asked
teaching self problems level said table results individual
made access theory disabled like games go found activities value system science
class without research impairment read number right
following serious employment experience however different game process approach lack open
groups possible work used learning design time blind using task model non
assessment likely problem will use visual article whole et al support group specific point
set part course rather student vi can students may i.e people life based related find
general practice information early one also case little user prior make help
means just development disabilities ii education screen skills university vision player second
want sighted activity users lot study social participants co needs disability first better effects studies
much physical person see need form impaired impact higher visually might load knowledge special
total get impairments three fig data example new many even important teacher report
significant accessibility systems must analysis way reported considered
subject reference high teachers two another good technology responses
still basic basis motivation us change experiences environment
working method

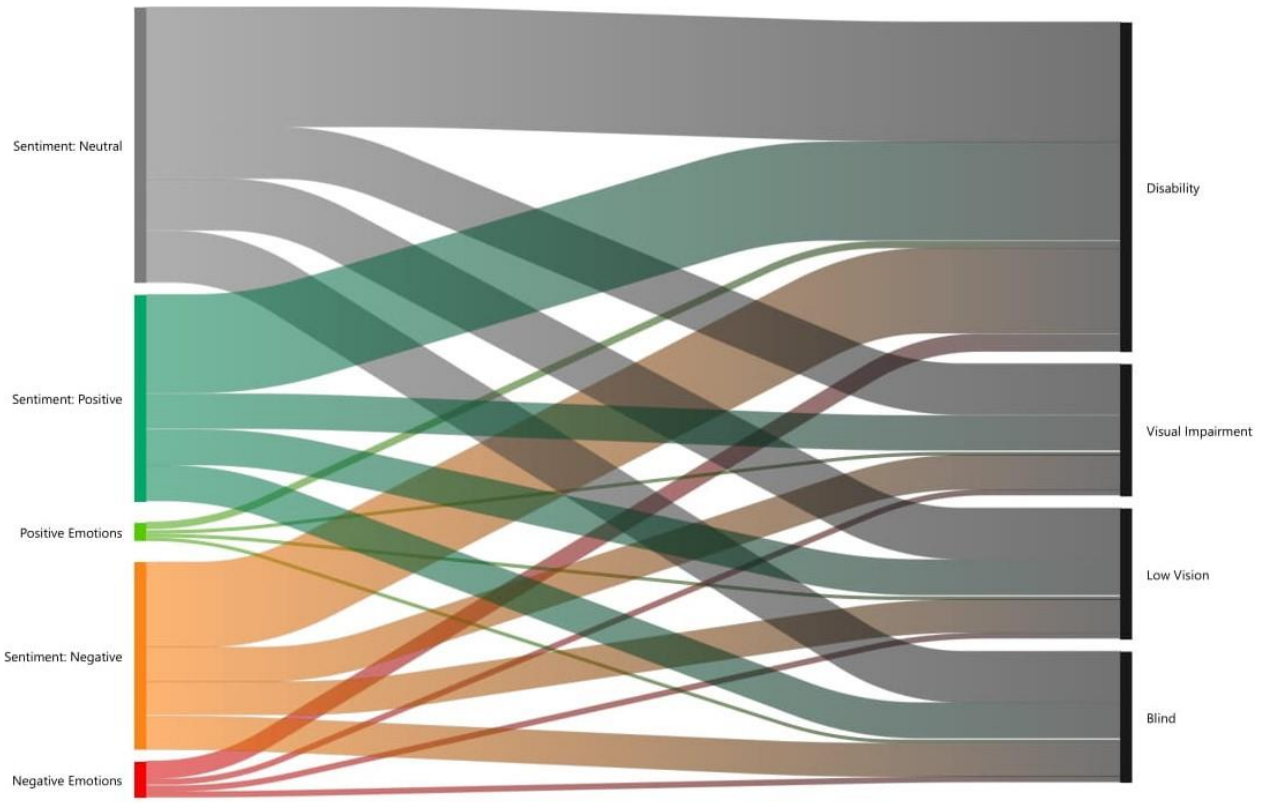

school world staff
including skills rights help
theory higher will children persons training
rather user within experience e.g based pp individual role
student data work time one different get blind key vision
visual exercise needs well
person inclusive good health attitudes
process group et education students disability still may using
etc https due impaired need social type
vi loss technology order
new test users uk us al people design can also systems level final
year participants values study impact value use around case physical like
means life information low human full disabilities game development example
project job reality
access learning research games system others
analysis able visually university environment activity
many support first important used self disabled planning
best way accessibility see results non


Rejection - Envy - Guilt
Hate - Disgust
Ammusement - Pleasure
Hope
Anxiety - Doubt - Insecurity
Distress - Desperation
Confusion - Shock
Anger - Frustration - Annoyance
Relief - Satisfaction
Determination - Inspiration - Awe
Fear - Startle - Worry
Infographics


Rejection - Envy - Guilt
Hope
Ammusement - Pleasure
Confusion - Shock
Anger - Frustration - Annoyance
Happiness
Anxiety - Doubt - Insecurity
Distress - Desperation
Determination - Inspiration - Awe
Relief - Satisfaction
Fear - Startle - Worry
Navigation


Negative Emotions
Sentiment: Negative
Positive Emotions
Sentiment: Positive
Infographics
Negative Emotions
Sentiment: Negative
Positive Emotions
Sentiment: Positive
Navigation
Sentiment: Negative
Negative Emotions
Sentiment: Positive
Positive Emotions
Education


Sentiment: Negative
Negative Emotions
Sentiment: Positive
Positive Emotions
Inclusive
Sentiment: Negative
Negative Emotions
Sentiment: Positive
Positive Emotions
Blind
Sentiment: Negative
Negative Emotions
Sentiment: Positive
Positive Emotions
Disability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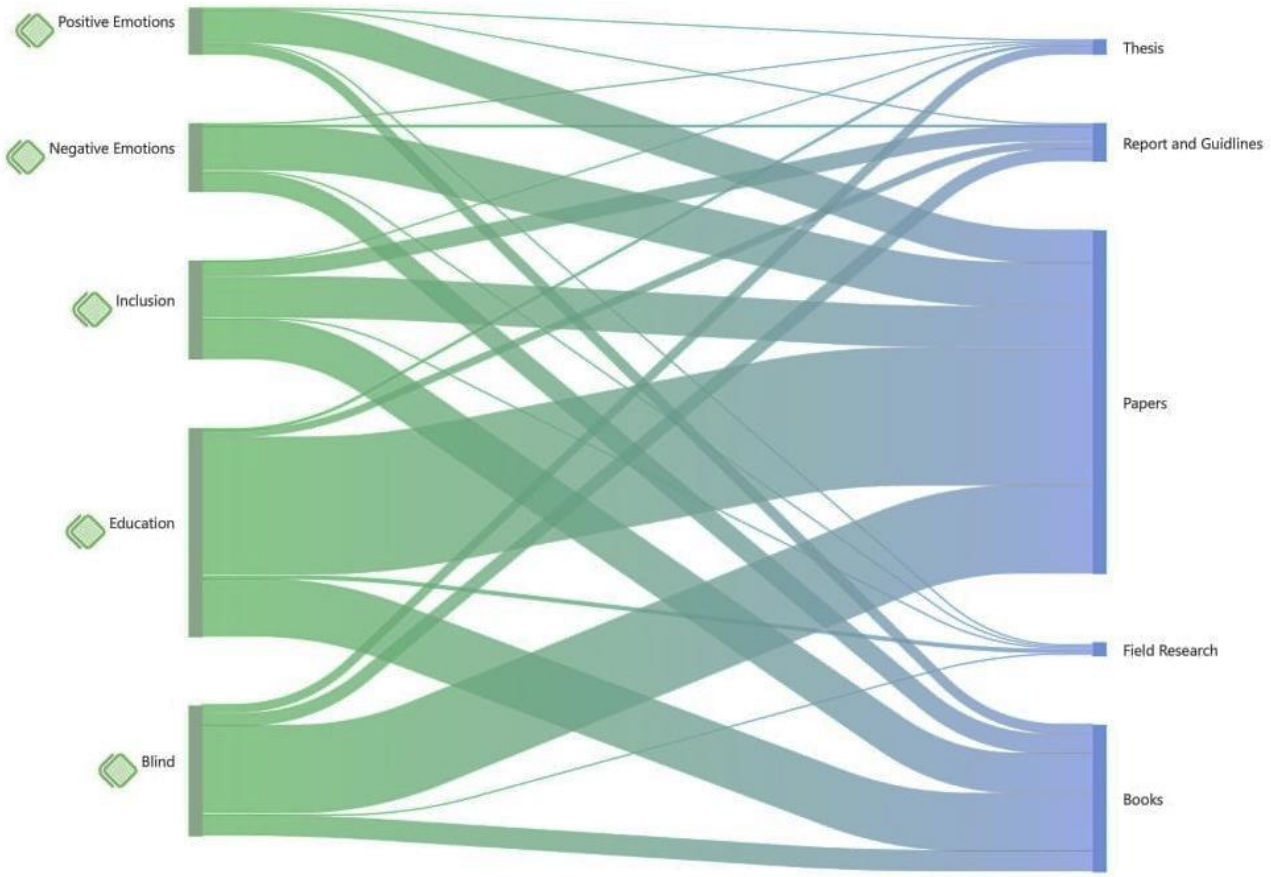
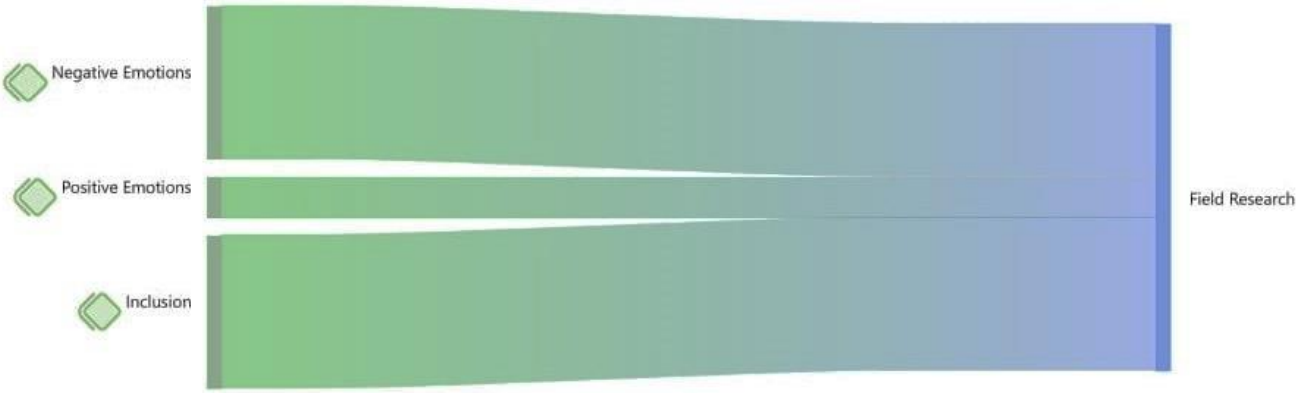
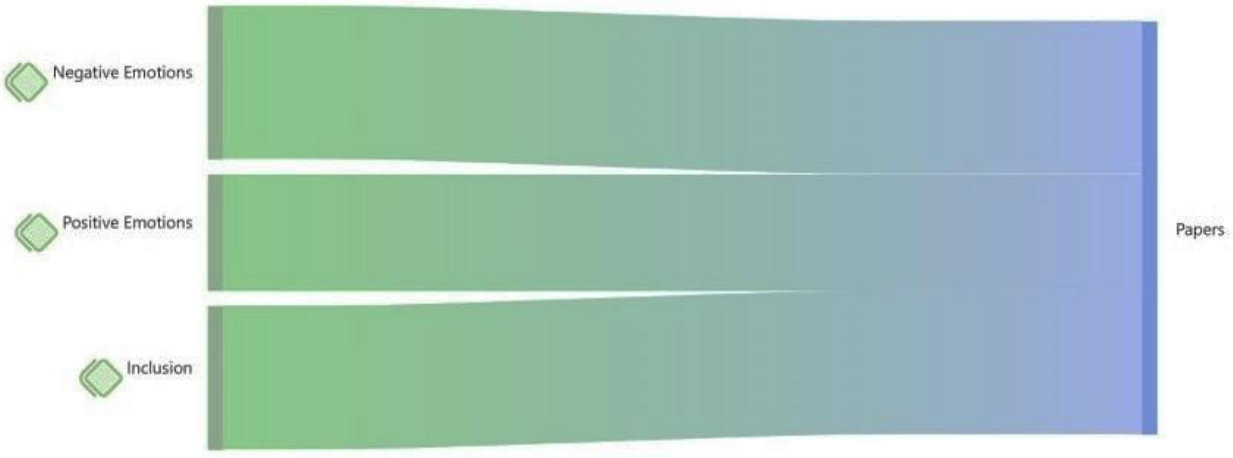
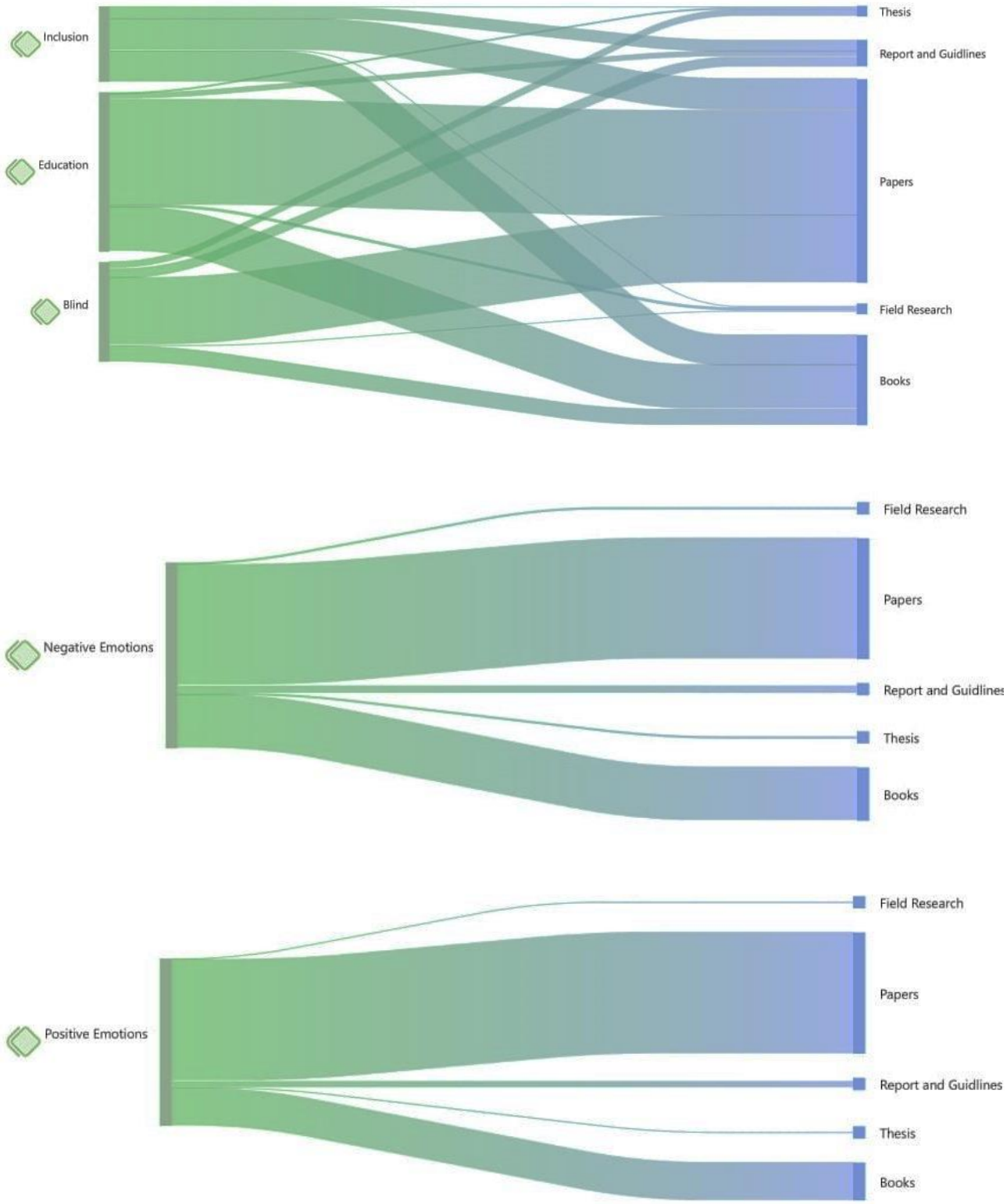
Sentiment: Positive
Positive Emotions
Sentiment: Negative
Negative Emotions
Disability
Visual Impairment
Low Vision
Blind


Positive Emotions
Negative Emotions
Inclusion
Education
Blind
Thesis
Report and Guidlines
Papers
Field Research
Books

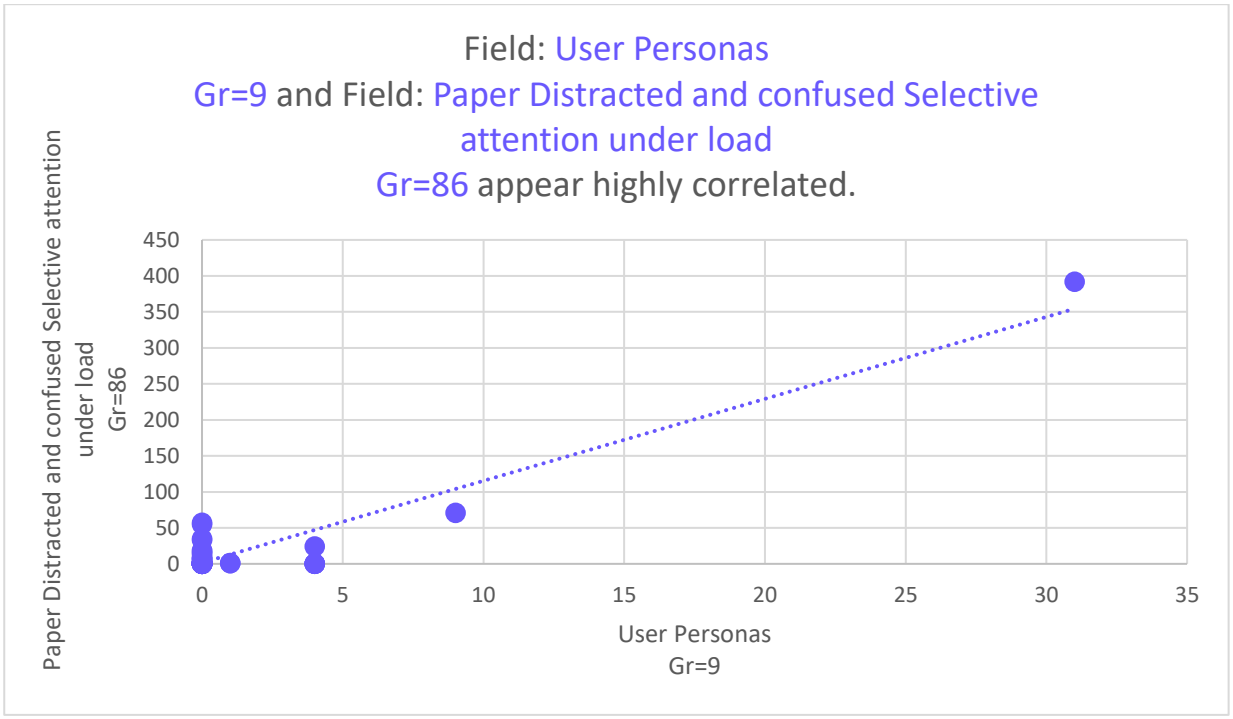

Negative Emotions
Positive Emotions
Inclusion
Field Research

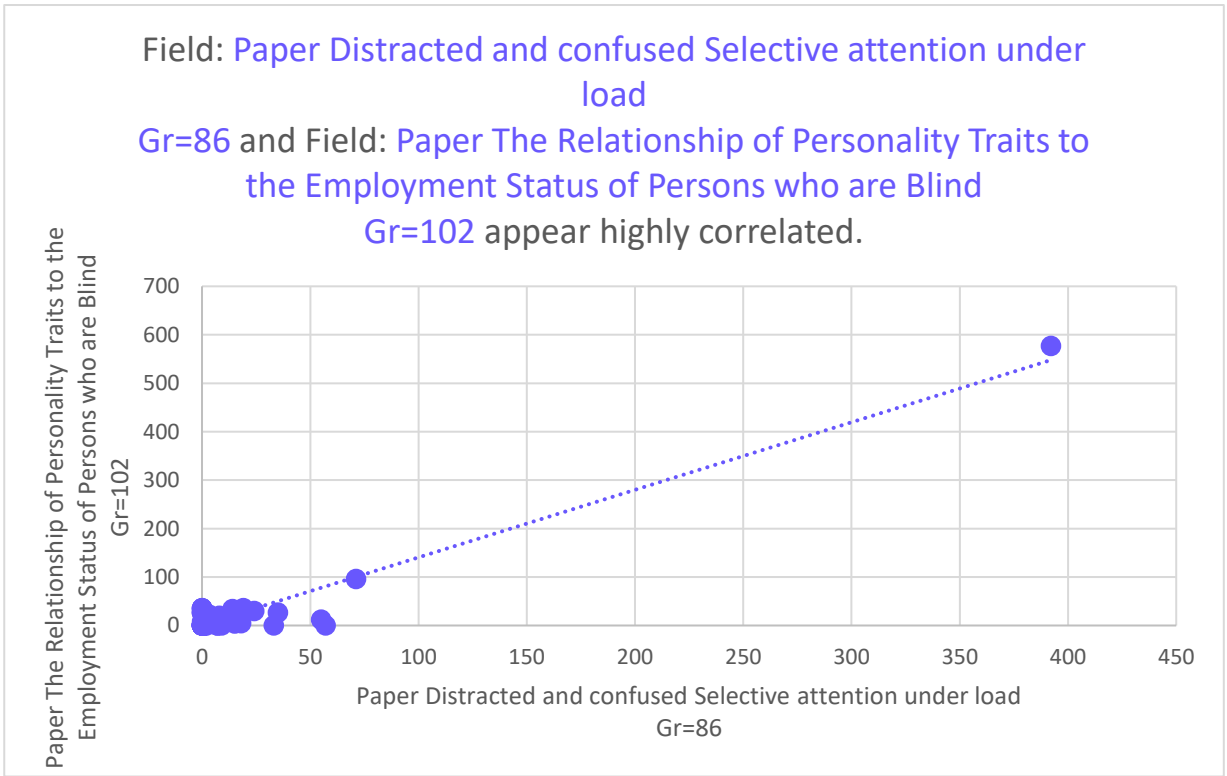

Negative Emotions
Positive Emotions
Inclusion
Thesis


Negative Emotions
Positive Emotions
Inclusion
Papers


Inclusion
Education
Blind
Thesis
Report and Guidlines
Papers
Field Research
Books
Negative Emotions
Field Research
Papers
Report and Guidlines
Thesis
Books
Positive Emotions
Field Research
Papers
Report and Guidlines
Thesis
Books

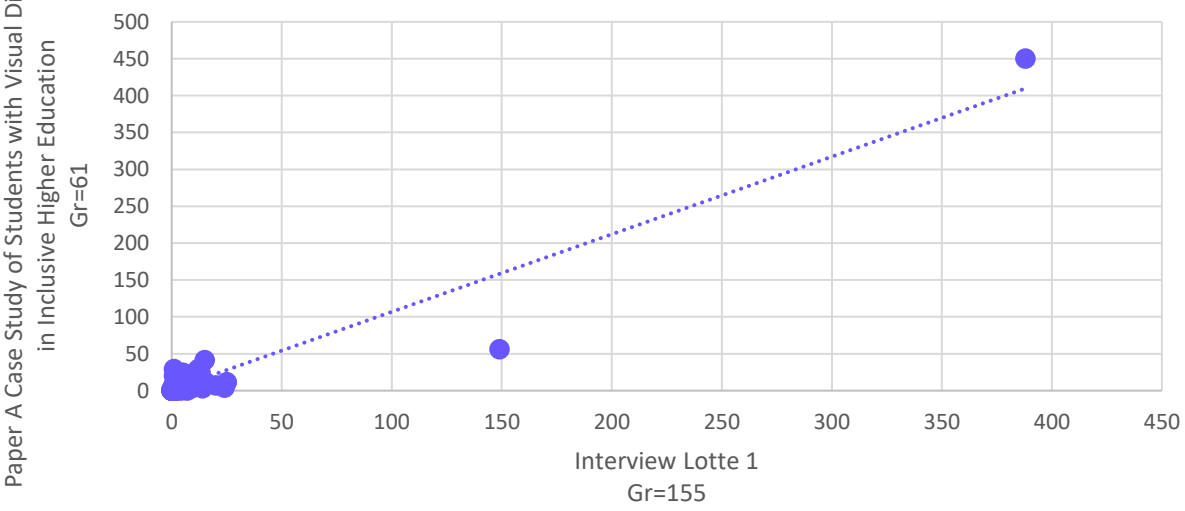
F.1 Examples of the correlation:





Field: Paper Motivation and Personality Maslow Gr=2898 and Field: Paper Academic attainment in visually impaired students in distance education Gr=75 appear highly correlated.

Field: Interview Lotte 1 Gr=155 and Field: Paper A Case Study of Students with Visual Disabilities in Inclusive Higher Education Gr=61 appear highly correlated.



Appendix G - Co-creation Creative Session

G.1 Detailed Plan

Session Plan

Road Map	Introduction	Icebreaker	Break	Problem Finding			Break	Idea Finding			Break	Solution Finding	Wrap-up
Diamond Phase				Diverging	Reverging	Converging		Diverging	Reverging	Converging			
Duration	5	5	5	15	7	8	10	20	5	5	5	15	5
Starting time	**18:00**	**18:05**	**18:10**	**18:15**	**18:30**	**18:37**	**18:45**	**19:05**	**19:25**	**19:30**	**19:35**	**19:40**	**19:55**
Ending time	18:05	18:10	18:15	18:30	18:37	18:45	18:55	19:25	19:30	19:35	19:40	19:55	20:00
Activities & Techniques	**Pitch the Problem as Given**	**What is your personality animal?**	Get in poition	• **Problem Owner Q&A (5)** • **purge (5)** • **Flower association (5)**	• **H2s**	• **Restating the Problem (SPARK)**	Coffee	• **Purge (5)** • **Animalization (7)** • **Forced fit (8)**	• **clustring**	• **Hits & Dots**	Coffee	• **Idea Gallery** • **Elevator Pitch**	Problem Owner pitch
Backup Plan			Start with QA even sooner		• 5W 1H		Play with ball and calling the animal name	• Creative confrontation • Random Words	• c-box	• Clustring	Yoga Stretch	• Making Poster	
Aim			Reserve time for possible delay	Fluency Obvious	6 per person Fluency obvious & beyond	2 per person talking & decision making	Mind break	Purge: 15 pp Animal: 15 pp Force: 10 pp	talking & decision making	4-6 top ideas for gallery	Mind break	4-6 ideas depicted	
Duties	problem statement: • ? RG: • rebellious people! • If know blind people • Techy • 5people			• focus • position RG & distribute supplies • POSTPONE JUDGMENT mindset • clarify process • reflect on outcome	• regain focus • divergent mindset • clarify process • generate H2 • check progress • reflect	• write down several statements • select 1-3 statements • capture essence • merge in 1		• POSTPONE JUDGEMENT • options with a criminal nature, not allowed, illegal • BEYOND OBVIOUS 1. what options does (posit) suggest for the Pap? 2. what does (posit) make you think of in relation to Pap?	• explain now - how - wow • cluster • let them talk & discuss	• explain hit & dot meaning • dot the hits 1. what do the dots tell you anout options? 2. are there some options that need further considerations ?		• read chosen ideas • group people (if too many people) • distribute idas to people and let them draw further explanations to the idea • ask then to pitch in 30 sec (elevator)	• thank RG and PO • ask PO for reflectio n
Notes	at least 10 flipboards at least 10 A3 papers to sketch			prepare flipboard with the key word	prepare flipboard with PaG	prepare flipboard with SPARK		• Purge flipboard • Criminal flipboard • Forced fit flipboard	C-Box flipboard	10 hits 2 dots per person		6 A4 paper and markers	

G.2 Overview

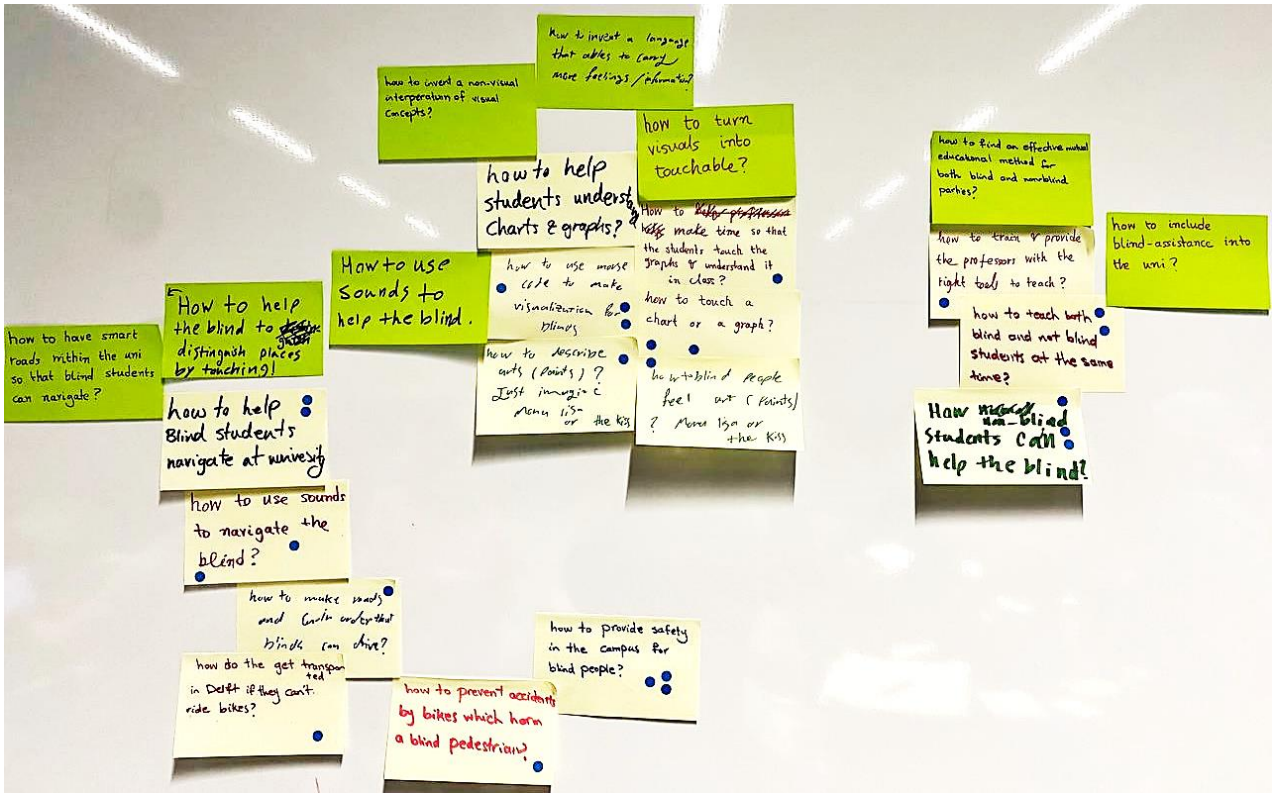
- Introduction
- Icebreaker
- Q&A Problem Definition
- Problem Finding
- BREAK
- Idea Finding
- BREAK
- Solution Finding
- presentation and wrapup

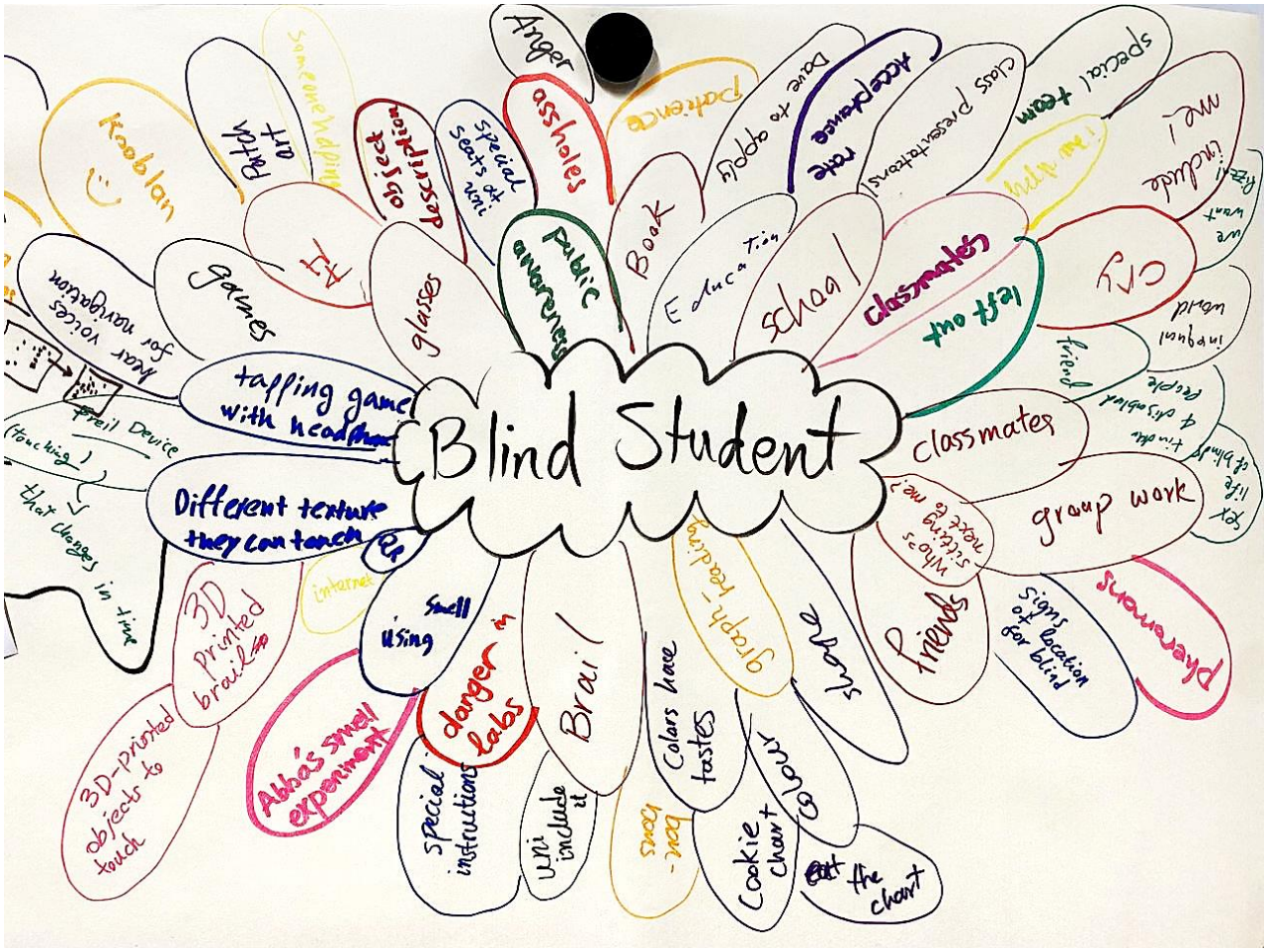
Problem Statement

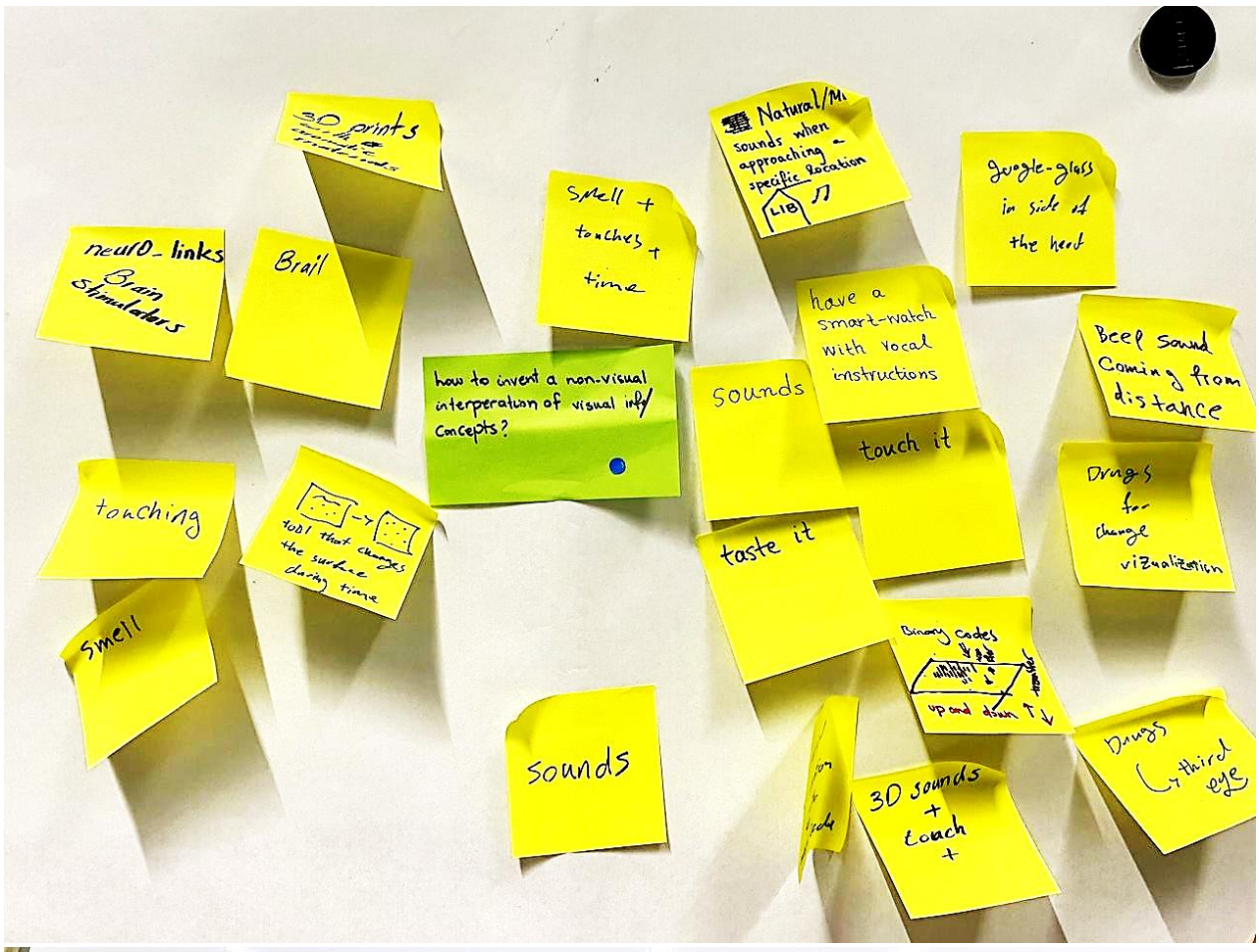
rule of SPARK
(for redefining the problem)

- Specific
- Positive
- Ambitious
- Relevant & Real
- Keep it Simple

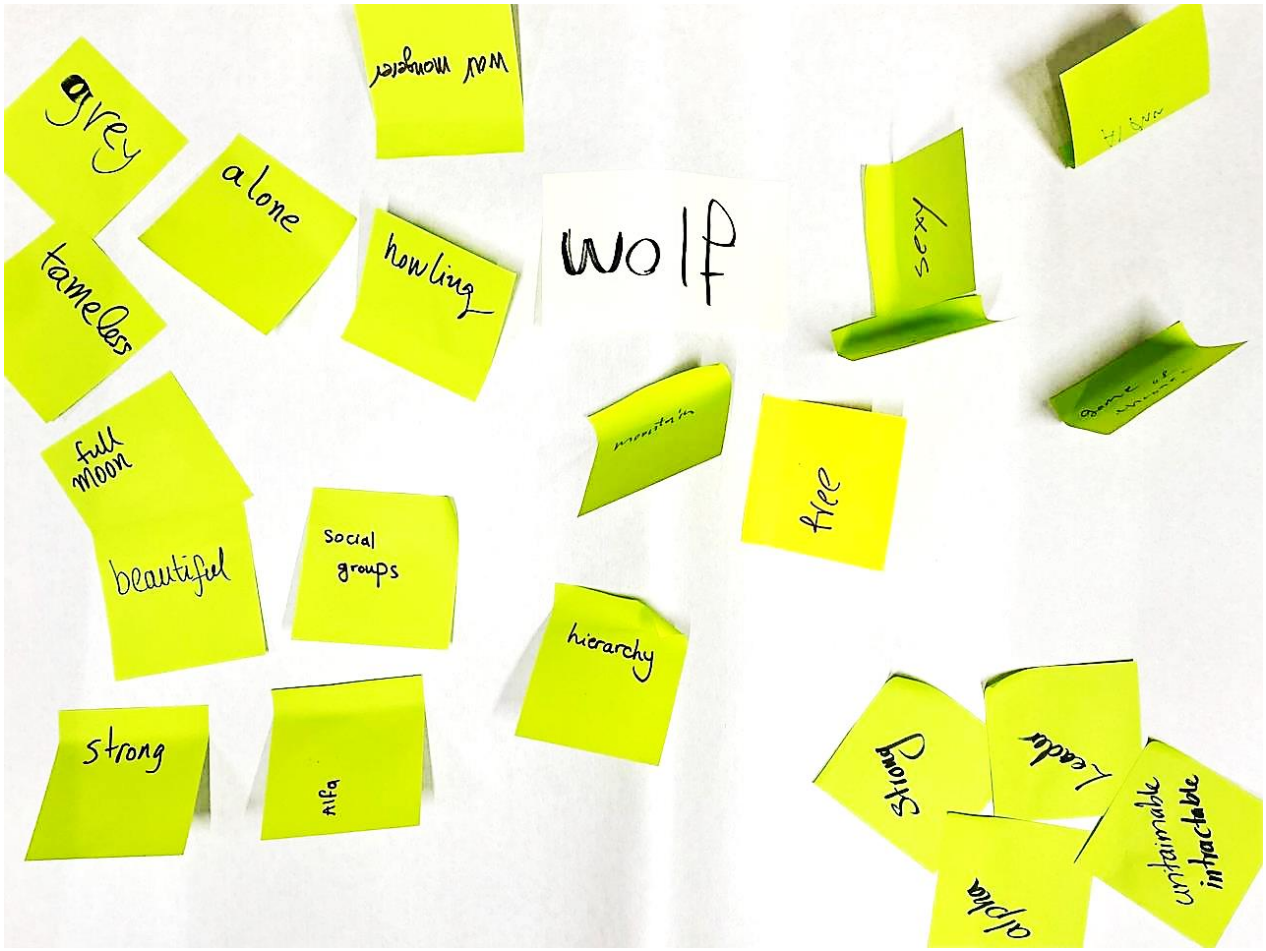
G.3 Raw Results

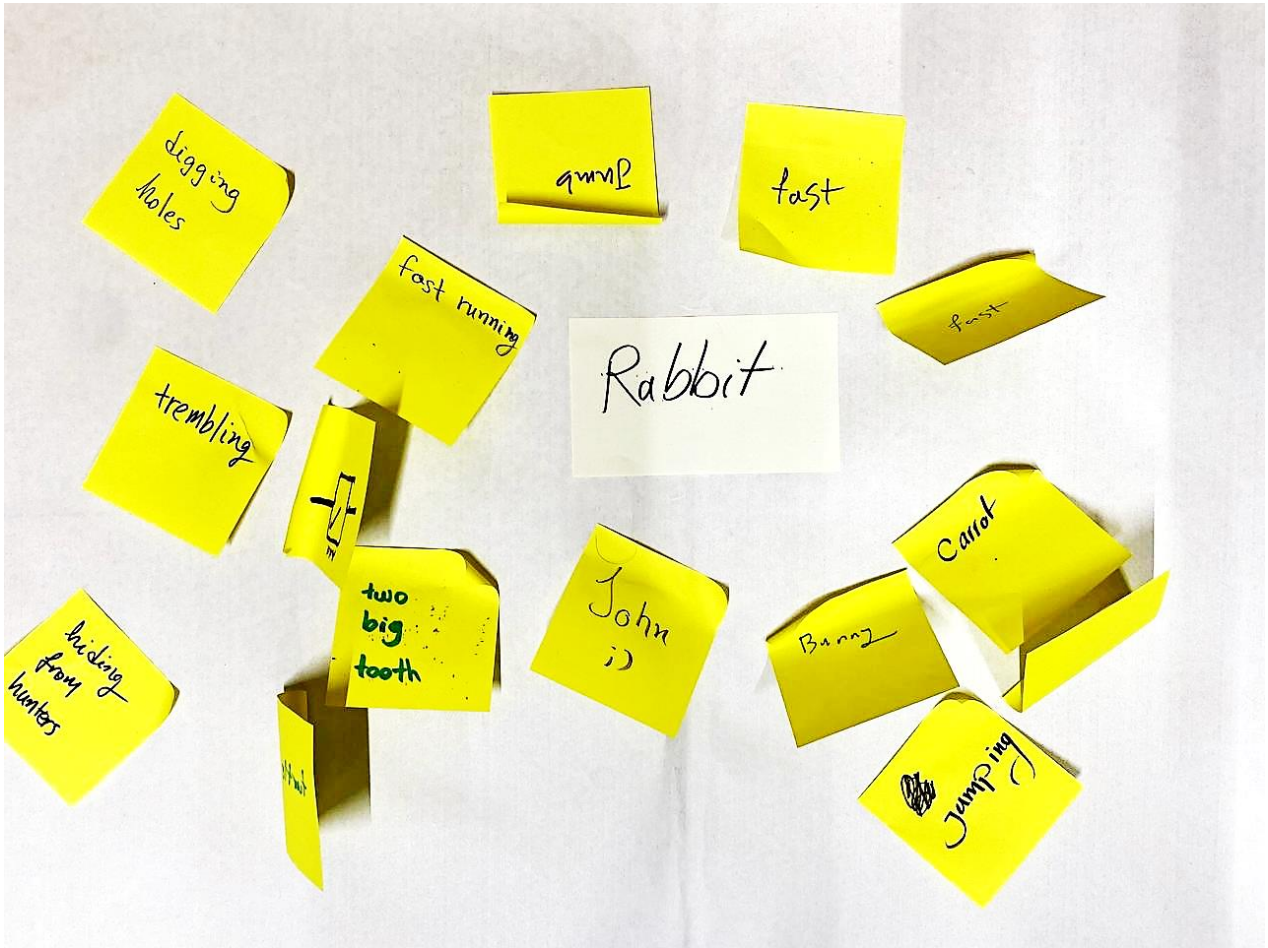




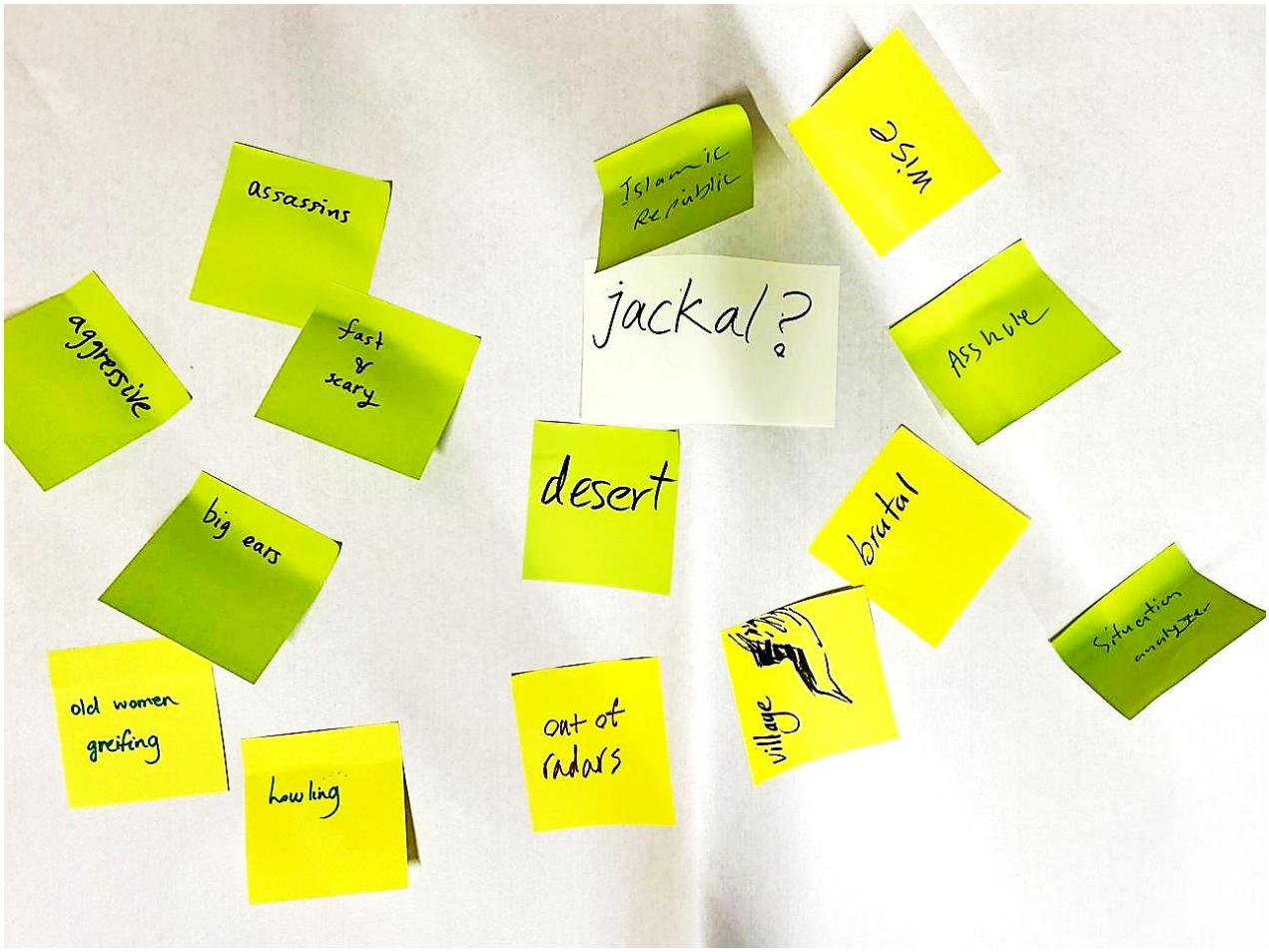

3D prints
Natural/M
sounds when approaching - specific location
LIB
google-glass in side of the head
neuro-links
Brain Stimulators
Brail
smell + touches + time
have a smart-watch with vocal instructions
Beep sound Coming from distance
how to invent a non-visual interperation of visual info/ concepts?
sounds
touch it
touching
tool that changes the surface during time
Drugs for change visualization
taste it
smell
Binary codes
up and down
sounds
Drugs
third eye
3D sounds + touch +


thief
3D printed
shapes for charts
use cartoon sounds for road safety
(bit bit when a car/bike is crossing)
how to invent a non-visual interperation of visual info/ concepts?
Cartoons
Independent
topography to understand location
a human-size
hierarchy
hug
fast
big ears
free
friendly & helpful
hiding from hunters
flexible
fast running
slime
2D books with traditional way → 3D
jumb
blind people special education village
plants flowers with their aroma can tell you
emmiters recievers
careless
ropes


wolf
grey
alone
howling
tameless
full moon
beautiful
social groups
hierarchy
strong
alfa
free
leader
alpha
untamable
intactable

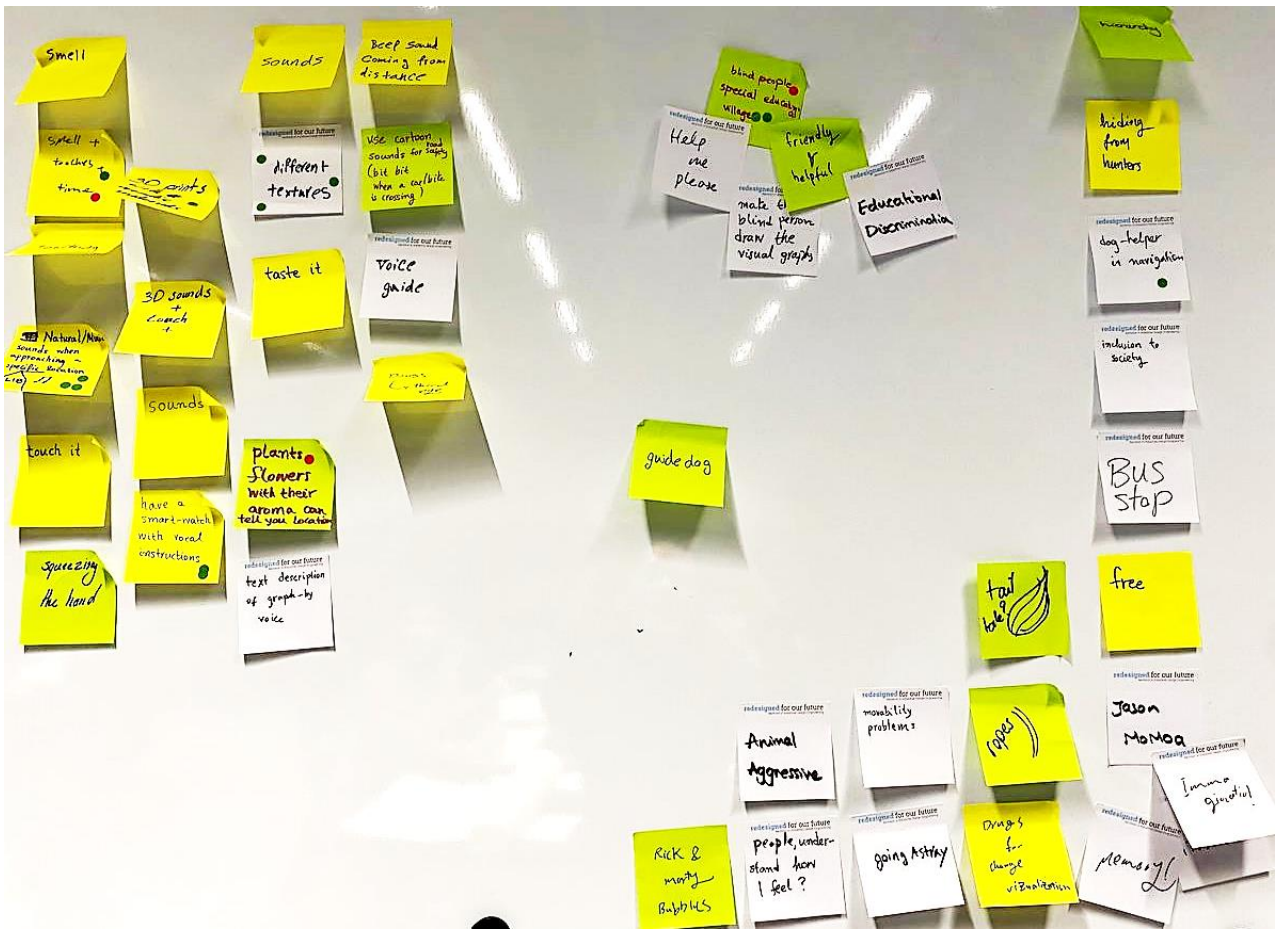

Rabbit
digging holes
fast running
trembling
two big tooth
hiding from hunters
fast
Carrot
Barny
Jumping


horse
free
good shape
decent
running
friendly & helpful
fast & furi.
fast
Like & Love girls
Elves
zorro

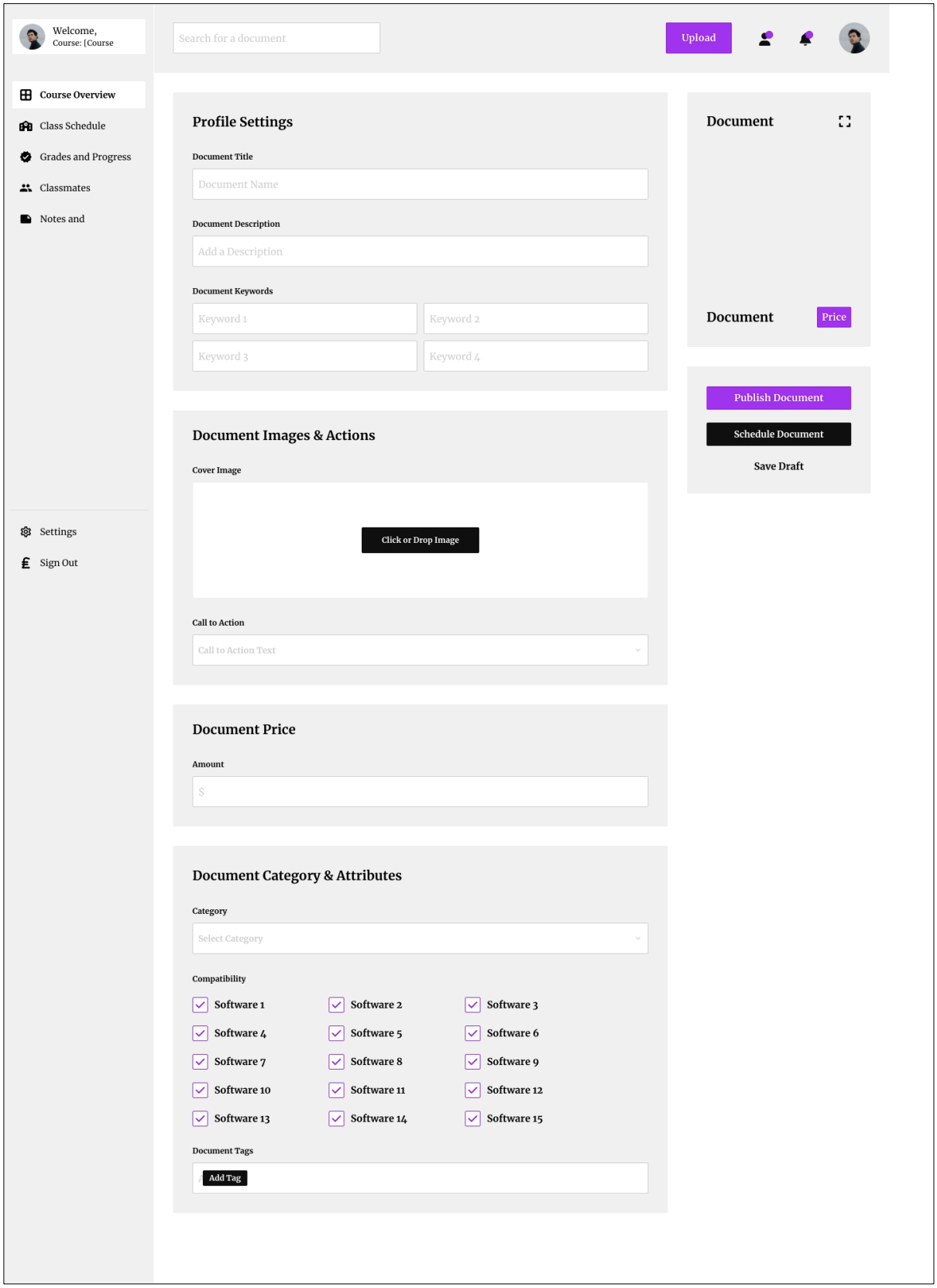

jackal?
assassins
Islamic Republic
wise
aggressive
fast & scary
desert
big ears
brutal
old women greifing
howling
out of radars
village

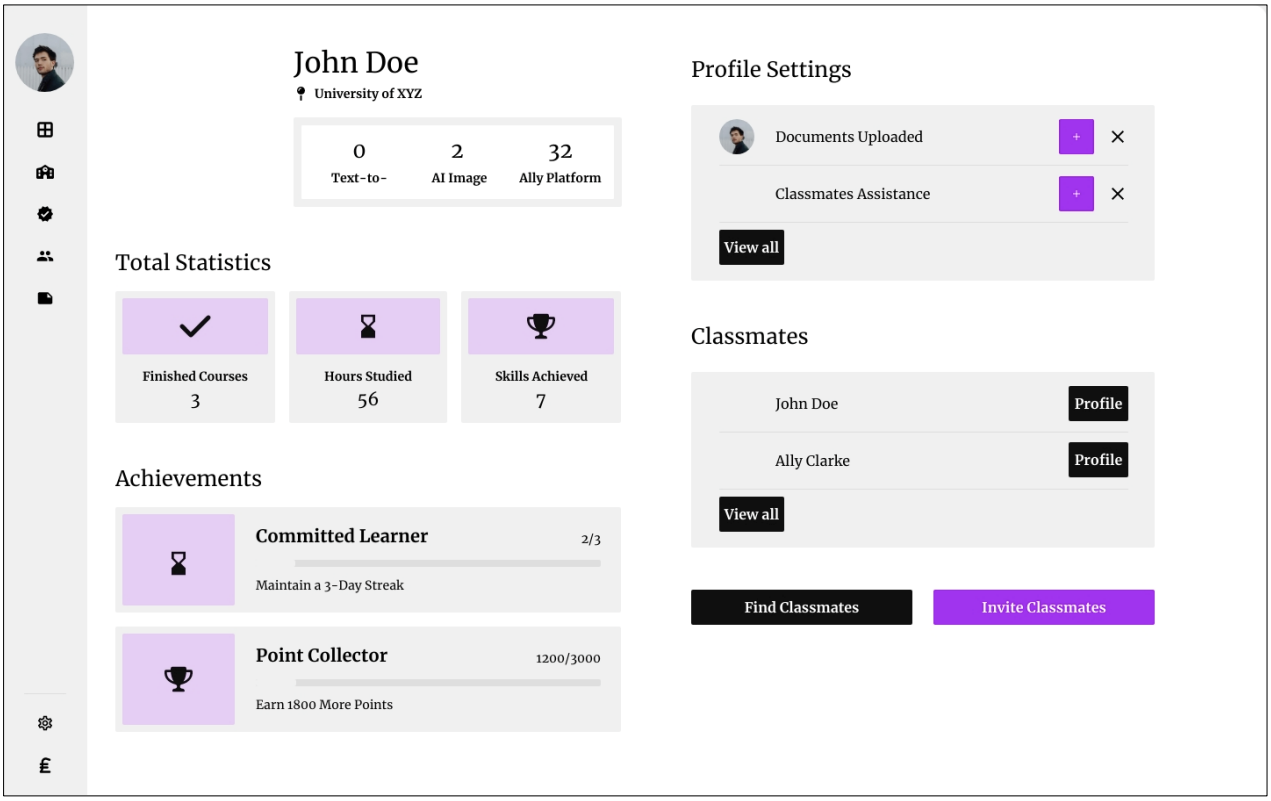

3D books with traditional way → 3D
Braill
Braill Mosaics
using vibration with the inverse code
neuro-links Brain Stimulators
3D Books Bath Digital
Interpretation !
Braill proof
AI glasses detect a building
public door
emotions receivers
3D printed
a human-size model of the room to be touched
User to infrastructure Communicator
Map reader
how to invert a non-visual interpretation of visual info/ concepts?
tag style seating in BSTV
AI assisted object recognition
GPS connected to the security to lost, they can find you
VR-sleep
google-glass in side of the head
topography to understand location
Landmark they can touch
3D-Spatial Visualization
village

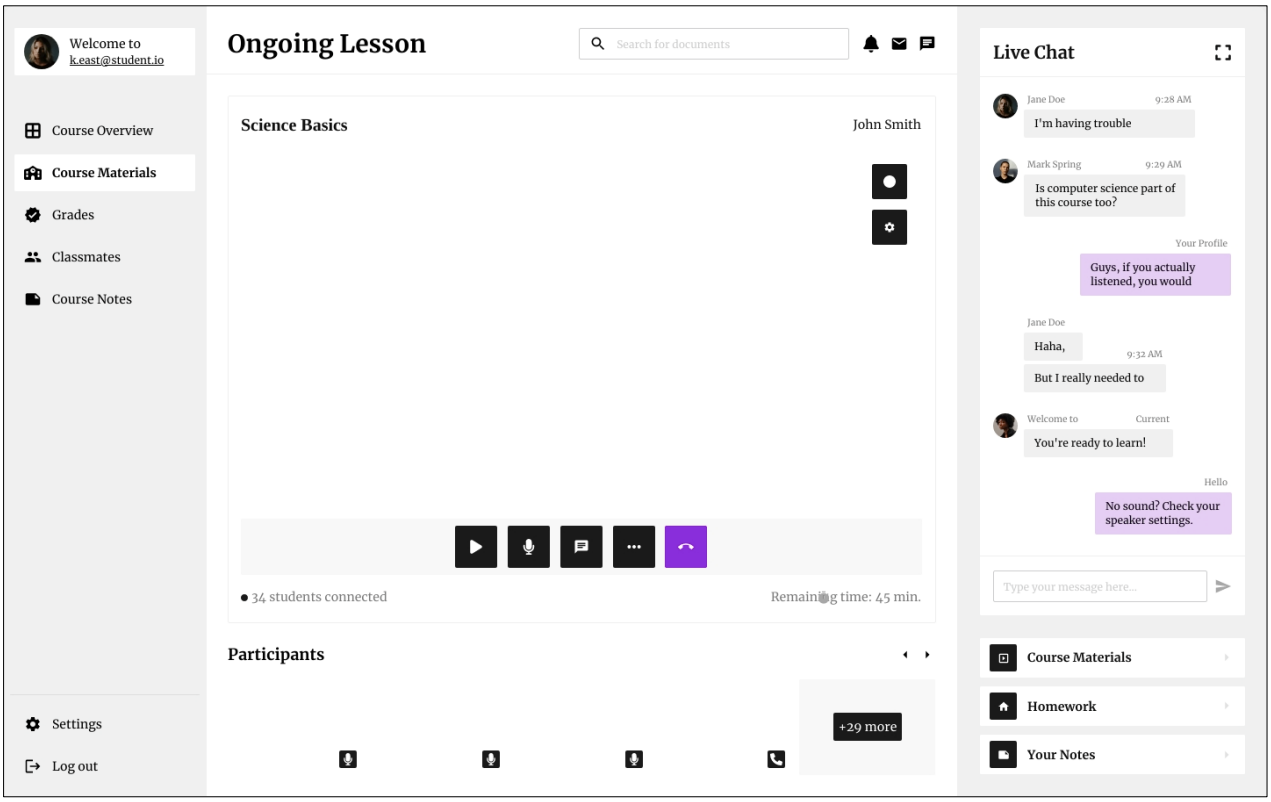

Interpretation !
3D prints
Smell
Natural/ sounds when approaching specific location
google-glass in side of the head
neuro-links Brain Stimulators
Braill
have a smart-touch with local vibrations
Beep Sound Coming from distance
sounds
touch it
taste it
Drugs for change visualization
Smell + touches + time
sounds
3D sounds + touch


Smell
Sounds
Beep Sound Coming from distance
Smell + teaches time
different textures
Use cartoon sound sounds for safety (bit bit when a car/bike is crossing)
taste it
voice guide
3D sounds + touch
Natural/Non
Sounds
touch it
plants flowers with their aroma can tell you location
have a smart-watch with vocal constructions
squeezing the hand
text description of graph-by voice
guide dog
blind people special education village
Help me please
Friendly & helpful
Educational Discrimination
dog-helper in navigation
inclusion to society
BUS stop
free
Animal Aggressive
mobility problems
ropes
Jason Momoa
Drugs for change visualization
people, understand how I feel ?
going Astray
Rick & morty Bubbles

Appendix H - Extra Prototype Screens




John Doe
University of XYZ
0
Text-to-
2
AI Image
32
Ally Platform
Total Statistics
Finished Courses
3
Hours Studied
56
Skills Achieved
7
Achievements
Committed Learner
2/3
Maintain a 3-Day Streak
Point Collector
1200/3000
Earn 1800 More Points
Profile Settings
Documents Uploaded
Classmates Assistance
View all
Classmates
John Doe
Profile
Ally Clarke
Profile
View all
Find Classmates
Invite Classmates


Welcome to
k.east@student.io
Course Overview
Course Materials
Grades
Classmates
Course Notes
Settings
Log out
Ongoing Lesson
Search for documents
Science Basics
John Smith
34 students connected
Remaining time: 45 min.
Participants
+29 more
Live Chat
Jane Doe
9:28 AM
I'm having trouble
Mark Spring
9:29 AM
Is computer science part of this course too?
Your Profile
Guys, if you actually listened, you would
Jane Doe
Haha,
9:32 AM
But I really needed to
Welcome to
Current
You're ready to learn!
Hello
No sound? Check your speaker settings.
Type your message here...
Course Materials
Homework
Your Notes

THE END