Design for Accessible Collaborative Engagement:

Making online synchronous collaborative learning more accessible for students with sensory impairments.

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Abstract

This thesis looks at the accessibility of collaborative learning and the barriers to engagement experienced by blind/visually impaired (BVI) students and deaf/hard of hearing (DHH) students. It focuses specifically on online synchronous collaborative learning after establishing that this format presented the greatest barriers, and that these student groups were not engaging.

Taking a design-based research (DBR) approach, five studies were undertaken to identify these barriers and determine potential interventions. The product of the research, a result of collaborative design by the participants in the study, is a framework for accessible collaborative engagement represented in the form of an interactive website model, the Model for Accessible Collaborative Engagement (MACE).

The studies involved representatives of all stakeholders in the collaborative learning process at the institution (the Open University): students, tutors, modules teams, academics, support staff, and the student union Disabled Students Group. These studies took the form of an online survey of 327 students, 10 interviews with staff and students, 6 staff workshops and a collaborative design focus group. With significant representation of the target groups (BVI and DHH) in all studies, and taking an iterative approach to the design, evaluation and construction of the framework model, the studies established that barriers existed in four main categories covering different themes:

1. Communications: aural, visual, screen reading and navigation, text and captioning, lip reading and non-verbal communications, interpretation and third-party communications, mode control, and synchronisation.

2. Emotional and Social Factors: familiarisation, support networks, self-advocacy, opting out, cognitive load, and stress and anxiety.

3. Provisioning and Technical Factors: dissemination, speed and pacing of sessions, staff training, participation control, group size, technical provisioning, and recordings.

4. Activity and Session Design: Volume of materials, advance materials, accessible materials, accessible activities, and session formats.

Interventions were designed that could reduce the barriers in each of these categories and themes by adjustments and changes from both the student and institutional standpoints. MACE is designed to be utilised by both students and staff to provide guidance and suggestions on how to identify and acknowledge these barriers and implement interventions to reduce them.

This research represents an original and essential contribution to the field of investigation. As well as informing future research inquiry, the model can be used by all participants and stakeholders in online collaborative learning to help reduce barriers for BVI and DHH students and improve inclusivity in synchronous online events.

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Declaration of Authorship

I declare that the work contained within this thesis is my own. My academic supervisors (Professor Denise Whitelock and Dr Tim Coughlan) have contributed through reflection and suggestion at all stages of research.

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Abbreviations

AT – Assistive Technology

BVI – Blind/Visually Impaired

BSL –British Sign Language

CoI – Community of Inquiry

CMC – Computer Mediated Communication

CSCL – Computer Supported Collaborative Learning

DBR – Design-Based Research

DHH – Deaf/Hard of Hearing

DSG – Disabled Students Group (Open University)

HE – Higher Education

MACE – Model of Accessible Collaborative Engagement

MOOC – Massive Open Online Courses

NMH – Non-Medical Helper

NVC – Non-Verbal Communications

OSCL – Online Synchronous Collaborative Learning

OU – Open University

OUSA – Open University Student Association

RQ - Research Question

SI – Sensory Impaired

TMA – Tutor Marked Assignment

VLE – Virtual Learning Environment

UDI - Universal Design for Instruction

UDL – Universal Design for Learning

UID – Universal Instruction Design

1 Introduction

This thesis explores the experiences of sensory impaired students in higher education in the UK, focussing specifically on online distance education and how to engage students in live collaborative activities. The importance of providing access to these collaborative experiences, the opportunity to work with their peers, and to give a voice to sensory impaired students is at the heart of this research.

1.1 Background

The specific impetus for this research came from tutoring and supporting a profoundly deaf student on a computing and communication module at the Open University.

One member of my tutor group for the module was a profoundly deaf student whose primary language of communication was British Sign Language (BSL). Our initial transactions were predominantly through emails in which she expressed an interest in attending an online tutorial but revealed that until that point (she was in her fifth year of part-time study) she had found them too difficult and time-consuming to access. These learning events were optional but designed to "support the learning, to help deepen understanding of the module material and practise applying knowledge."[1] A further stated objective of the tutorials was to give students a chance to connect with other OU students, and to engage with a tutor and benefit from their expertise. To attend she would need to make various preparations and complete administrative processes in advance, for example to request a BSL interpreter. If I was not the tutor on the specific tutorial she wanted to attend there would be a need to negotiate with another tutor (whom she may not know) to attend their session and make the appropriate adjustments. To overcome organisational complexities and time constraints I was asked if I could provide one-to-one sessions instead with the student to cover the materials and subjects provided by the tutorials. Whilst this gave the student the academic support she required, it highlighted the fact that she was being isolated from her peers and that she was missing out on the collaborative aspects of discussing and working with her tutors and peers. In our one-to-one sessions she revealed that she had just accepted that online tutorials were not going to be available to her. She had enjoyed face-to-face tutorials in the past where, with the use of an interpreter and through lip reading, she was able to be an active participant.

[1] https://www.open.edu/openlearn/mod/oucontent/view.php?id=76174&section=3
(Accessed: 29/09/2022 09:18)

This experience led to my contemplating why the online sessions were particularly problematic and if something about the format and nature of these sessions was creating these barriers for Deaf and Hard of Hearing (DHH) students. As someone with progressive hearing loss myself it was something I was beginning to be more aware of in my facilitating role as a tutor as hearing and 'translating' voices during tutorials was becoming more difficult.

Whilst improving accessibility for DHH students in online tutorials was my initial focus, the principles of universal design, and the importance of equality of access in education, were also concepts with which I felt and affinity. The initial solution to making learning more accessible for DHH students was to provide more visual materials and means of communication, but then this posed the question, is this going to create additional barriers for Blind or Visually Impaired (BVI) students? It became apparent that in addressing barriers for DHH students I might end up creating barriers for BVI students or vice versa.

Improving inclusion was always going to be at the heart of this and making these sessions universally accessible was going to be important. Looking at barriers to engagement for both DHH and BVI students seemed a sensible place to start. I decided to focus this research on these two groups of students, which I collectively refer to as sensory impaired (SI). This use and choice of specific terminology, and the variations in opinion, is discussed in more detail in the Disability, Accessibility, Inclusion section of the literature review.

Identifying the potentially problematic areas then became a consideration. Were there other aspects of the student experience that SI students were being excluded from? Was this exclusion being experienced by students at other Higher Educational institutions? The research took place at the Open University, but the findings should be applicable to online education in a wider context.

To contextualise this research, it is necessary to consider and understand a little about the Open University (OU) and their approach to distance learning in order that it can later be compared to other distance learning providers. Discussion of the applicability of this research outside of the OU is covered in both the Practical Contributions and Limitations sections of the Conclusions chapter. For the present it is necessary to understand something about the specific and wider context of this research.

1.2 Rationale

The last ten years have seen significant changes in the landscape of online education, particularly the move to more online and hybrid forms of higher educational qualifications (Iniesto *et al.*, 2018; Almusharraf and Bailey, 2021; Fonseca, García-Peñalvo and Camba, 2021). From using the computer as a tool for learning, technology now provides both the context and communication tools for learning (Lo and Hew, 2021; Parrish, Williams and Estis, 2021). This learning environment has expanded and developed in multiple directions as technology has evolved, internet connections have become faster, and the ability to communicate live online at a distance has become more widespread. The impact of the pandemic has sped up this process and significantly changed the way people work and communicate, increasing familiarity with and adoption of conferencing tools (García-Morales, Garrido-Moreno and Martín-Rojas, 2021). In Higher Education (HE) online tuition became more prevalent during the global pandemic, with many universities making a rapid and unplanned move to online provisioning. Additional research was undertaken as a consequence and re-ignited the debate about the effectiveness of online collaborative learning which is covered in general, and with respect to the changes brought about by the pandemic, in the Literature Review section of this module. The key difference between the Open University, the location of this research, and other universities with a more on-site based history was that the OU had the infrastructure and many years of experience of delivering education at a distance, a large proportion of this online, so that the shift to entirely online tuition had less impact than at many institutions, and the OU was arguably better prepared for it.

Whilst technology has provided many more tools, environments, and formats for both learning and collaborating this has also made engagement with other students and tutors more complex increasing the multiplicity of factors that need to be considered when delivering education in this context. Learning theories and new evidence have developed, changing expectations of how teachers and students interact which have influenced perceptions and policies reflecting the way learning is approached, moving from a concept of passing knowledge from teacher to student, to acknowledging the importance of collaboration and social interactions in the learning process (Stahl, 2018). Implementing these changes in an online environment has presented complexities, but are these complexities in working collaboratively in an online live environment causing some students to be excluded in unforeseen and sometimes unseen ways?

1.3 Context of The Open University

The Open University has been delivering distance education for more than fifty years, and online learning for more than twenty years, with the aim to give "anyone, anywhere the power to learn" with a mission to "to make learning accessible to all"[2]. The student population at OU at the time of the research was over 200,000 students. Reasons for studying are diverse "there is no typical OU

[2] https://www.open.ac.uk/about/main/ (Accessed: 29/09/2022 09:28)

student. People of all ages and backgrounds study with us, for all sorts of reasons – to update their skills, get a qualification, boost their career, change direction, prove themselves, or to keep mentally active." [3] 36,400 students declaring a disability studied with the OU in 2020/21. It is presumed there are also many more who have undeclared disabilities.

Teaching at the OU is through what it calls "supported open learning" aiming to be flexible, inclusive, supportive, and social. Module materials are developed by multi-disciplinary course teams including academics, educational technologists, media specialists, and external examiners. This learning is supported by a resource of more than 5,000 tutors who support students throughout a module including marking assignments, providing feedback, delivering online and face-to-face tutorials, supervising field work, and teaching on day and residential schools. The OU is organised in faculties (see Table 18 Faculty) so this term is used throughout.

Tutor Marked Assignments may involve group projects or experiments and tutors will facilitate and support these.

1.4 Research Aims

The overarching aim of this research is to improve inclusiveness for SI students. The approach to reaching this goal has been to identify barriers to engagement and potential interventions/solutions that might reduce these barriers allowing SI students to actively participate in collaborative learning and engage and benefit from working with their peers in an online synchronous environment.

An essential component of this research was the involvement of students from the key groups, deaf/hard of hearing and blind/visually impaired. It was crucial that these students had an active and significant role in the research process. In addition, it was essential to involve representatives of all participant roles in the tutorials/group work events, particularly tutors but also module teams and student support officers. A Design-Based Research methodology was selected to support this grounded, practice-based approach. In line with the approach outlined in Chapter 3 Methodology, the research presented in this thesis was iterative and utilised mixed methods. This approach supported inclusion of all voices and a cumulative dataset, implementing an iterative design process to develop the model based on the analysis of the data from the various studies.

[3] https://www.open.ac.uk/about/main/strategy-and-policies/facts-and-figures (Accessed: 29/09/2022 09:18)

The final aim of the research was to produce a tool/framework that would be useful for all participants in online synchronous collaborative learning events demonstrating and providing guidance as to how to improve inclusivity and reduce barriers for SI students.

1.5 Contributions / Purpose of thesis

The purpose of this thesis and the resultant model is to:

- Improve engagement in online synchronous learning activities for students with SI
- Improve inclusion for SI students in online synchronous learning activities
- Facilitate opportunities for SI students to participate in collaborative learning activities

1.6 Thesis Structure

This introductory chapter, Chapter 1, has presented the context and rationale behind the research. Chapter 2 presents a review of historical and recent literature to both understand how the pedagogical fields have evolved and acknowledge recent developments. This literature review is broadly grouped under the areas of Collaborative Learning, Learning Environments, and Disability, Accessibility and Inclusion and follows the path through these three areas of study to that of collaborative online learning for sensory impaired students in higher education (HE). It concludes with recent research relating to the impact of the pandemic on the fields of study.

Chapter 3 presents an overarching view of the methodology used in this research. It starts with a discussion of the research paradigm and the choice of a pragmatic mixed methods approach moving on to a discussion on the use of Design-Based Research (DBR) as a basis for the studies, a methodology designed by and for educators, with the aim of increasing the impact of educational research into practice. It then goes on to outline the research design, methods and data evaluation methods that describe the underlying structure of this research.

Chapter 4 discusses the ethical protocols and considerations required for the complex series of studies and the handling of sensitive data.

Chapter 5 presents the findings of the research, and this again reflects the iterative nature of the process with analysis taking place at the end of each stage of the DBR research with results fed into subsequent stages. Chapter 5 constitutes the largest proportion of the thesis with the findings for each chronological study. This includes detailed analysis of each study, the method used, and discussion on both the specific study findings, the cumulative findings and a summation including a reflection on the changes occurring and the status of the model at that point in time. The final section of chapter 5 contains a discussion of the findings of the full research process.

Chapter 6 presents the Model of Accessible Collaborative Engagement (MACE) which is the model that represents the framework that was developed alongside, and is a product of, the research.

Chapter 7 Discussion concludes with general reflections on the research and findings, how the research questions have been addressed, future possibilities, and lessons learned. This discussion is presented in relation to the different student and staff perspectives broadly associated with barriers and interventions respectively. Studies 1 (survey) and 2 (interviews) set out to explore the students' perspective of collaborative learning, and experiences with online and face-to-face formats, and both synchronous and asynchronous options. Studies 3 (interviews) and 4 (focus groups – workshops) set out to explore the staff and institutional perspectives. These two perspectives were brought together in study 5 (focus group – collaborative design), a focus group with both staff and student participants.

In chapters 5 to 7 the barriers and potential interventions are established. In the findings chapter (5), these emerge directly from the data and are discussed in this context. The framework built from these findings and developed by the focus group is then presented as a learning tool in chapter 6. The discussions chapter explains how these became defined and grouped and relates them back to the literature indicating how they fit in with existing research and contribute to it.

The final chapter, Chapter 8 Conclusions, draws together an overview of the main findings, the practical, theoretical, and methodological contributions, and the limitations of this work, finishing with future possibilities.

2 Literature Review

This chapter explores the research relating to the issues identified in the introduction and examines the key bodies of academic knowledge that relate to this research project.

The literature review takes a narrative rather than systematic approach but utilises some existing systematic studies in specific area.

2.1 Approach

The literature process was started prior to the data collection and analysis, and it was an ongoing process throughout the research, right up to the writing of the thesis. The library at the Open University was used extensively to access the relevant literature and access and use several of the databases available there (including Sage, SpringerLink, and ACM). External resources included Google Scholar, ResearchGate, and Mendeley which was used additionally as the referencing tool. Core texts were used in collaborative learning (Barkley, Major and Cross, 2014) and e-learning and disability (Seale, 2014). A Snowballing technique was used in which citations from key articles and texts were used to find related articles. Key phrase searches were performed, and a list of key words and alternative spellings and synonyms was kept for reference (see appendix (g)).

As the literature review delved deeper into the subjects the key words and nuances of phrases used emerged (so, for example, 'synchronous' rather than 'live', and use of on-site as an alternative for face-to-face). For particular areas of research such as the impact of the pandemic on teaching publications date restrictions were used, but initially research parameters were across broad date ranges and subjects. Once the data collection had started, the research was extended my to cover aspects that arose as a result of the data analysis.

As the literature review converged into the three main areas of collaborative learning, learning environments, and disability/accessibility/inclusion a list of key word, themes, and subthemes was established which were applied and related to the literature review.

When it came to writing up the literature, it was determined that a narrative approach would be best suited to the research to show the paths of research from collaborative learning concepts, the effect of different learning environments, and what was understood about these when working with sensory impaired students. The three main themes covered were huge areas in their own rights so a systematic review was going to be too extensive.

In order to identify the gap in the research a separate database of the literature with central arguments, contribution, relevance to the research, gaps, and links to themes and subthemes was created so that the narrative could be related back to this list.

2.2 Introduction

The chapter is in four main parts. The first part explores collaborative learning, the second learning environments, the third accessibility, inclusion, and disability and the fourth section focussing on sensory impairment in Higher Education (HE). These set the context for this research establishing the purpose and role of collaborative learning in HE by exploring it conceptually, historically, and through its application in research. With technology the nature of learning environments changed, with opportunities for both face-to-face and online learning as well as synchronous and asynchronous collaboration, and the ability for collaborative learning to take place at a distance, so the impact of these environments on collaborative learning is explored in the second part. The third part then looks at how these environments have impacted students with sensory impairments by looking at accessibility, inclusion and disability. The final section in the chapter brings together DHH and BVI research in all three areas looking at specific studies involving DHH and BVI students in HE.

The literature review takes a macro approach to exploring these three key areas, and in each area then drills down to the more specific foci and findings that elucidate the problems being addressed. These key areas are obviously not mutually exclusive and are in themselves major areas of research with huge bodies of knowledge. The intention is to provide an overview of the field of study, the core aspects and concepts, specific studies that will have an impact on this research, and to explore the overlap between the three areas. By looking at the paths between these areas, both discrepancies in perspectives and the connections between them, and by taking this encompassing overview it is hoped to contextualise and identify the gaps that this research addresses.

Therefore, the first section starts by considering collaborative learning, what makes it important, what we mean by engagement, and the pedagogical implications of failing to/being unable to engage in collaborative learning. The section explores concepts, terminology, definitions, and the history and growth of collaborative learning within Higher Education to quantify its importance.

With an understanding of the meaning, key research, and value of collaborative learning, the second section then considers the environment in which that learning takes place. It looks at the broad ranging concepts of what constitutes a learning environment and the components involved, looking at physical, virtual, and conceptual interpretations. It then focusses on research in the areas of synchronous/asynchronous learning, face-to-face and online tuition, and Virtual Learning Environments (VLEs). Here the differences between online, face-to-face, and blended learning are reviewed, as are synchronous and asynchronous learning experiences. The concept of 'learning environments' is explored and considered in terms of platforms, physical environments, virtual learning environments and the use of assistive technologies.

Thirdly, barriers to participation in the collaborative learning process are explored; those that are common and those that are specific to disability. This third section therefore looks at inclusion, accessibility, and disability. Again, definitions and terminology are reviewed, in general terms, in education, and more specifically in HE.

Research involving the target groups of sensory impaired students is then explored in relation to the three areas (collaborative learning, learning environments, and inclusion/accessibility). Recent research, specific case studies, and prevalent perspectives of all three fields are reviewed to explore the gaps and questions arising from these perspectives and how these have informed and constructed the questions to be addressed by this research.

The recent pandemic necessitated moving HE teaching online for many institutions, and consequently raised additional issues and produced research relating to this switch to an online learning experience for many students and the impact that this has had. A short section at the end of this chapter will discuss this.

2.3 Collaborative Learning

Synchronous online learning events such as tutorials and group work activities allow students to engage with and work with their peers and tutors. So why is this type of learning important? Research has explored the nature and value of collaborative learning, the different interactions students have, the concept of presence, how collaborative learning practices impact on the wider student experience, and collaborative learning frameworks such as Communities of Inquiry (CoI). I start by considering its origins, different terminology, and key concepts in order to contextualise it. Moving forward, the transition of collaborative learning to online is discussed in the Computer Supported Collaborative Learning (CSCL) section.

2.3.1 Historical Foundations

Collaborative learning is a well-researched and extensively field-tested pedagogy. There is a large body of research, dating back decades, that suggests that the use of collaborative learning elements has a positive outcome in terms of student learning (Vygotsky, 1978; Gokhale, 1995; Dillenbourg, 1999).

It is useful, in order to understand what sensory impaired students might be excluded from, to look back at the historical growth of Collaborative Learning, seeing why it is considered important, how the concepts of collaborative learning developed, and to appreciate how these concepts have been formed and advanced.

Traditional teacher-centred approaches to learning are often based on an individualistic or competitive approach to learning. A student is there to be taught and the teacher to impart the knowledge with peer interaction based on a competitive hierarchical comparative model whereby students are encouraged to compete rather than collaborate with each other. In a traditional, instructional method such as lecturing there is an implied role for the student as a passive observer rather than an active participant (Kain, 2003). Collaborative learning has been contrasted with more traditional competitive or individualistic learning, drawing on behavioural and cognitivist theories to describe how collaborative learning promotes higher achievement than competitive or individualistic learning (Johnson, Johnson and Smith, 1998). Acknowledgement of the importance of interactions between learners, rather than simply a passing of knowledge from teacher to student, can be traced back more than a century. From Dewey (1887), through Piaget (1959), and Vygotsky (1978), the foundations of collaborative learning were established, with constructivist theories of learning acknowledging the significance of peer interactions in the construction of knowledge and understanding.

Dewey's educational philosophy, "Democracy and Education" (Dewey, 1916), provides the foundation for community-based experiential learning linked to public problem-solving. Dewey emphasised that "action-oriented, collaborative, real-world problem-solving education can function as the most powerful means to raise the level of instrumental intelligence in individuals, groups, communities, societies, and humanity." (Benson, Harkavy and Puckett, 2007, p. 87)

Vygotsky's theories stress the fundamental role of social interaction in the development of cognition (Vygotsky, 1978). He believed that community plays a central role in the process of "making meaning". Vygotsky approached this from cognitive theory, suggesting that students learn by actively making connections and organising them into meaningful concepts. In traditional, individualised methods of learning, students are seen as passive observers. Learning in this way may result in surface learning - that which is easily forgotten. Well-crafted collaborative learning activities challenge students to be active participants in the acquiring and organising of knowledge that results in reformatted neuronal networks, thereby promoting deeper learning. Students come to group learning with diverse backgrounds, but their knowledge overlaps enough to allow for a common base for communication. Thus, theoretically at least, students can pool and share knowledge such that they know more as a group than they do as individuals. Vygotsky uses the term "zone of proximal development" for the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under guidance or in collaboration with more capable peers (Vygotsky, 1978). This zone is the difference between what a learner cannot do and what the learner can do with help. Then, by working with their more capable peers (or tutors in an interactive way), individual students may learn concepts that are just beyond their current level of development. There is also an implication that this learning is 'deeper' and more effective than traditional teacher led methods.

Collaborative learning activities provide students with opportunities to take turns modelling and imitating different knowledge and skills as they observe and learn from each other. Activities performed independently by a student within this context may not extend the student and instead provide 'surface' learning rather than 'deeper' learning.

Whilst earlier work focused on student-to-student interactions, Bruner (1986) believed that when students start to learn new concepts they need help in the form of active support. To begin with, they are dependent on this support, but as they become more independent in their thinking and acquire new skills and knowledge, the support can be gradually removed. This form of structured interaction between the student and the teacher is reminiscent of the scaffolding that supports the construction of a building. It is gradually dismantled as the work is completed. This can be linked conceptually with an interactive online tutorial, for example, where a tutor may initially facilitate group work on a specific problem, and then gradually encourage a group to work independently of their direct support.

Bandura (1971) conceived of learning as a social act and believed that individuals learn behaviours and attitudes through direct or indirect observation. Learners watch another person who acts as a model and then imitate what they are watching. It is through watching others that one adopts attitudes or forms an idea about how to perform new behaviours, and thus learning occurs by way of interaction between behavioural, cognitive, and environmental influences. This is a more passive perception of collaborative learning but still at its essence requires the communication channels to be open between participants in the process.

The growth of collaborative learning has been built on these foundations: the deeper learning potential and extending learning into the "zone of proximal development" and the contribution to socialisation and sense of belonging. Use of social media (Al-Rahmi, Othman and Yusuf, 2015; Wandera *et al.*, 2016) and cloud computing (Al-Samarraie and Saeed, 2018) in recent years has further enabled this growth in collaborative learning.

2.3.2 Definitions

Whilst historically collaborative learning has grown from cognitive theory, and the key principles of the value of peer interactions remain the same, how collaborative learning is conceptualised and understood is fundamental to assessing the perspectives, as the interpretation and implementation of collaborative learning can vary significantly. Different definitions can add a layer of complexity when comparing studies so that informative and appropriate comparisons may not be possible. In order to describe and situate my research I shall explore these definitions and the concepts required to reflect on my research, how I have interpreted and applied the term collaborative learning, and its relationship and placement in the body of knowledge.

The terms ‘collaborative learning’, ‘cooperative learning’ and ‘peer engagement’ have all been used in the context of educational group work (Dillenbourg, Barclay). These terms have been interpreted, adopted, and used in a multiplicity of different ways

Dillenbourg, whilst arguing that defining it is not useful in itself, provides a broad but, in his words, ‘unsatisfactory’ definition of collaborative learning as:

> *“a situation in which two or more people learn or attempt to learn something together.”* (Dillenbourg, 1999, p. 1)

He goes on to explain that this statement can be interpreted in different ways: ‘two or more’ can be any number, ‘learn something’ can be various different activities and ‘together’ can be interpreted as numerous forms of interaction. This, then, is a very loose, adaptable interpretation which can be applied to a variety of scenarios.

Collaborative learning has also been described as a broad, integrated approach to group learning. Barkley et al. provide a more distinct definition requiring specific elements, describing collaborative learning as:

> *“an umbrella term for interactive group work that has three essential elements: intentional design, co-labouring and meaningful learning.”* (Barkley, Major and Cross, 2014, p. 13).

These three terms then warrant brief definitions in their own right. Intentional design suggests learning activities structured to provide opportunities for learning. Co-labouring implies participants actively engaging in working together towards the stated objectives, rather than taking a passive observational role. Meaningful learning requires that participants increase their knowledge or deepen their understanding. This ‘meaningful’ learning is comparable to the ‘deeper’ learning of

Vygotsky. It is acknowledged that this meaningful learning and co-labouring cannot be achieved without support and intentional design. They too provide a theoretical and pedagogical rationale for collaborative learning suggesting that students learn by integrating new information into their existing understandings, through scaffolding activities, by imitating others, through interacting with others, and when they seek understanding. We have here a generalised term from Dillenbourg, and a more clarified definition from Barkley et al.

The phrase 'cooperative learning' has been used interchangeably with, as a subcategory of, and as a more structured version of collaborative learning. There is debate as to the difference (if any) between collaborative and cooperative learning (Flannery, 1994; Brufee, 1995; Weimer, 2013). Whilst some see the terms as interchangeable, others have argued that cooperative and collaborative are two distinct approaches with the goal of cooperative work being that of learning by working closely together and mutually support each other to find a solution whereas the goal of collaborative learning is to develop autonomous, articulate, thinking people even if at times such a goal encourages dissent and competition (Brufee, 1995). This could, perhaps, suggest that there are different epistemological perspectives at work in the underlying approaches to cooperative and collaborative learning.

But is it necessary to firmly establish a definition? Dillenbourg in considering the terminology suggests that exploring aspects of a definition is useful in order to put concepts into perspective rather than in order to establish a definitive definition (Dillenbourg, 1999). To effectively assess the outcomes of my research some sense of definition will be necessary to provide metrics for evaluation, and in undertaking the empirical data collection and subsequent analysis. The three essential elements defined by Barclay et al. (intentional design, co-labouring, and meaningful learning) are a useful touchstone to determining what is and is not collaborative learning, so these are the guides I have chosen to adopt in my research in determining what can and cannot be considered collaborative events in the context of the Open University, and in the analysis and evaluation of the data.

This also requires some consideration of how 'collaborative' activities such as online tutorials actually are. Some may fail to fit with this definition tending to become more of a tutor led lecture event, but still adhere to a learner-centred rather than teacher-centred model of teaching. However specific or broad the concept of collaborative learning to be adopted what I would argue is essential at a higher level is that a student is able to communicate and interact with their peers, and that the context of their learning allows for engagement and therefore potentially collaboration. If a student cannot engage owing to barriers, then it becomes more of a passive experience with both their peers and the tutors. Collaboration requires co-labouring which in turn requires interaction with peers. Any barriers to this interaction are, in effect, barriers to collaboration.

Engagement and the benefits of collaborative learning have extended beyond the pedagogical benefits of engaging with peers to considerations of the social benefits and the concepts of Communities of Inquiry (Oliveira, Tinoca and Pereira, 2011; Garrison, 2019) and transactional engagement across three types of interaction: learner-content, learner-instructor, and learner-learner (Leach and Zepke, 2011; Wdowik, 2014).

2.3.3 Social Learning

Extending beyond the pedagogical value of collaborative learning, the notions of group cognition, of Communities of Inquiry, and the value of interactions between participants have suggested that the benefits of collaborative learning extend beyond academic success.

The notion of group cognition proposes that human thinking and learning is at its core interactional. Stahl suggested that we acquire our ability to think and to learn by adopting practices that arise within small-group interactions. Our thinking is responsive to, and conditioned by, "our embeddedness in a physical, interpersonal and cultural environment—particularly the immediate discourse or action context" (Stahl, 2018). According to group cognition theory, thinking and learning take place in the interactions between people and across small groups of interacting individuals.

A Community of Inquiry (CoI) is broadly defined as "any group of individuals involved in a process of empirical or conceptual inquiry into problematic situations" (Stahl, 2005). Dewey in particular was responsible for applying this concept in an educational context. This concept has been integrated with the concept of collaborative learning by researchers such as Garrison and applied to online learning communities. It sees knowledge as "being something that is embedded within a social context, legitimised by intersubjective agreement within the community." (Garrison, 2019, p. 25)

The CoI framework developed by Garrison et al. (2000) has an emphasis on the need to create an effective learning community that enhances and supports deep approaches to learning. This provided a viable theory for understanding the dynamics of learning in online and blended learning contexts and for developing effective learning communities. The framework is constructed around the notion of three presences: social, teaching, and cognitive. The implication in this research is that all three presences need to be both present and in balance in order to provide 'deep and meaningful' learning experiences. This is all based on a collaborative constructivist approach for designing learning environments.

Hannafin et al. (2004) asked questions of collaborative learning, in order to validate it: What has been learned? and How did the understanding evolve? The developmental and perceptive aspects of collaborative learning and their relationship to ‘deeper’ learning and the cognitive process is explored in their work, and Akyol and Garrison suggest that the CoI framework they developed and its dynamics has shown promise in addressing these questions, and that this has potential to provide links between collaborative approaches to learning and higher-order learning outcomes (Akyol and Garrison, 2011).

Other researchers have realised the fundamental role of social interaction in learning and development. It was noted by O’Donnell and King that social interactions, even interactions that involve social conflicts, can lead to cognitive reorganisation and development. Whilst focusing on these aspects there is also an acknowledgement that interactions outside of the formal learning environments also contribute to positive outcomes, aspects such as academic success, learning and personal development and a sense of belonging. The ability to collaborate with other students enables these interactions. Learners' active engagement with learning materials and strategy use is critical to learning success (O’Donnell and King, 1999).

Wdowik (2014) looked at ‘transactional engagement’ both in and beyond the classroom, describing it as a “multidimensional complex construct” that contributes to a better learning experience. He followed up on Zepke and Leach’s discussions (Zepke and Leach, 2010; Zepke, Leach and Butler, 2014) of the indicators of good transactional engagement where they suggest three indicators of good transactional engagement being:

- teaching and teachers are fundamental to engagement
- learning is active and collaborative and promotes learning interaction
- students engage in deeper education experiences and broaden their academic capabilities.

He declared that the implementation of an online learning community using interactive technology “has unequivocally shown to have a positive impact on transactional engagement outside the classroom.” (Wdowik, 2014, p.272)

The findings suggested that when teachers use appropriate online technologies (student centred) coupled with providing a supportive, productive, challenging, and safe environment it promotes rich and meaningful interactions, and active and higher order thinking skills. Therefore, students become more engaged in their learning process leading to a greater student experience.

Thus, from the perspective of social constructionists and constructivists, instructional approaches that support collaborative learning may be the only effective way to teach because it is only through social interaction that we learn (Topping, 1996). Barriers to social interaction could therefore be considered to be barriers to learning.

In 'Collaborative Learning Techniques' (Barkley, Major and Cross, 2014) a useful summary of research and ideas on collaborative learning is provided. This again looks at the terminology but goes on to attempt to clarify why collaborative learning is important. They also tackle online as well as onsite collaborative learning and the differences between these two mediums. Whilst this publication is now several years old it still provides a useful discussion of the subject. They suggest that intentional design is arguably more essential in online courses and that online instructors believe that online design requires more planning and structure than onsite to be effective. In terms of their notion of co-labouring they suggest additional challenges when collaborating without physical communication cues "such as eye contact and body language to help them make sense of each other and their shared tasks" (Barkley, Major and Cross, 2014, p. 75), an interesting observation in the context of SI students, where for DHH students there is a greater dependency on these cues, and BVI students are less able to use them. They also raise the challenges of inexperience of working collaboratively online and that of planning time when activities may be both synchronous and asynchronous. With meaningful learning they suggest that this might be harder to measure and may require new ways to document the attainment of planned goals.

After considering the history and evolution of thinking and research in collaborative learning it is necessary to move on to more contemporary research and the contextual changes that have impacted thinking.

2.3.4 Computer Supported Collaborative Learning

With the growth and ubiquitous use of computer technology the means and modes possible for collaborative work were extended. Computer Supported Collaborative Learning (CSCL) is now a broadly adopted term to describe the use of technology in collaborative learning (Stahl, 2015; Ludvigsen *et al.*, 2017). CSCL is now considered an educational paradigm which uses technology in a learning environment to help mediate and support group interactions in a collaborative learning context. This might mean using technology to control and monitor interactions, to regulate tasks, rules, and roles, or to in some way mediate the acquisition of new knowledge.

As technologies have evolved the nature and context of CSCL has too. Initially Computer-Mediated Communication (CMC) options such as discussion forums were the focus of CSCL research (Weinberger *et al.*, 2005). As additional tools and connectivity improved further discussion tools such as video conferencing were then incorporated into learning environments to enhance group discussion (e.g. Ting et al., (2018)). Visual representation tools allowed more complex ideas and the sharing of understanding, and the introduction of virtual environments and artificial intelligence (virtual reality, simulation, games) have been deployed to promote conceptual learning, problem solving and increase learners' engagement and motivation. The effects of CSCL have become increasingly more complex as the available tools and means and modes of communication have expanded.

Whilst initially more focused on use of computers as tools within a more traditional classroom environment, CSCL saw collaboration move away from these more traditional face-to-face approaches into Virtual Learning Environments (VLE) with a plethora of tools and technologies, formats, and mediums in which the collaboration can take place. This collaboration could be synchronous via mediums such as live tutorials and group sessions taking place in virtual classroom environments, or asynchronous via mediums such as wikis, forums or social media tools. Whilst the argument for the importance of collaborative learning remains the same, the learning environment raises significant changes in the way collaborative learning can be implemented within an institution, as well as inclusion and accessibility considerations.

Stahl et al. saw CSCL as "an emerging branch of the learning sciences concerned with studying how people can learn together with the help of computers" where "the learning takes place largely through interactions among students" (Stahl, Koschmann and Suthers, 2006, p. 1). At the core of CSCL is still the need for students to work, communicate, and interact with each other but this now allows asynchronous communications such as questions placed on forums. Time and location independent responses, and lack of immediacy of response, allows for considered, constructed responses and time for reflection. Learning together is still the primary objective of CSCL but is built on the premise that collaborative knowledge construction and problem solving can effectively be assisted by technology.

2.3.5 Limitations and criticisms of Collaborative Learning

Are there any criticisms of collaborative learning? What are the limitations of its usefulness? There are a number of limitations and questions arising from the research associated with collaborative learning including the reliance on the strength and quality of activities, participation and barriers to student engagement, and the impact of technology. Whilst there seems to be general agreement on the value of collaborative learning, there is also acknowledgement of the complexity of providing good collaborative experiences.

Much of the research into the value of collaborative learning places a requirement that the students participate in well designed and constructed activities. The quality of these activities, associated learning materials, and the comparison with more traditional equivalents is going to have an impact on the outcomes of the students whether these are worked on collaboratively or independently. Evaluating like-for-like scenarios therefore becomes complex and much of the positive research supporting collaborative learning is reliant on well scaffolded and supported group work. Learning outcomes for collaborative learning are often based on the assumption that the group work is done well.

> *"A carefully planned and executed collaborative experiment cannot fairly be evaluated against a generalised 'across the board' non-collaborative approach."* (Barkley et al., 2014, p13).

One of the significant barriers to implementing collaborative learning is that students may lack experience in the role of a participant in collaborative learning online. It may be new to them in a higher educational context, or indeed they may not have experienced collaborative learning practices in their former education. This can make the transition to collaborative learning more daunting. A collaborative exercise in isolation within a predominantly self-determined or tutor-led model of study, is often perceived as a negative component, with students hesitant to commit. The suggestion is that intensive instructor guides and scaffolding in time-sensitive collaborative behaviours is necessary for successful group work. Kreijns et al. (2003) suggest that students may not be prepared to be effective collaborators a view supported by Kwon et al. who conclude that students are not "well cultivated to be effective collaborators as they may suffer from collaboration by simply being exposed to or forced to collaborative learning" (Kwon, Liu and Johnson, 2014, p. 198). Students who have little or no previous experience of collaborative learning are often reluctant to participate. In distance education especially, there may have been an active choice by the student to work independently and the decisions to choose distance learning rather than traditional onsite learning may have been determined by this independent learning approach.

To some extent the OU teaching model provides a concrete example of this as it tends towards limited use of collaborative learning in compulsory elements so that it remains open to all. Even when there are collaborative activities built into a course there are often alternative workarounds for students, such as those in secure environments, and students with disabilities. The Badged Open Course design utilised on OpenLearn is intended to be studied entirely individually with no collaborative aspects. This means students are able to take the course at any time and at any pace. From an institutional perspective this also means no costs for support or monitoring (Law, 2015).

There is often a reluctance by students to work on collaborative projects and anxiety related to taking part. Expectations can be low, and emotional responses heightened. There are often perceived inequalities in the extent, quality, and timeliness of contributions of group members which can cause tensions, particularly when as an assessed component of a module. A pitfall that might be unacknowledged is taking for granted that participants will socially interact simply because the environment makes it possible and neglecting the social (psychological) dimension of the desired social interaction (Kreijns, Kirschner and Jochems, 2003). Wang and Burton (2010) summarised the failure of collaborative learning activities attributing them to three main problems: group tension (Smith, 2005), perceived group status (Nuthall, 1999; Barron, 2003), and social loafing (Salomon and Globerson, 1989). They describe social loafing as "the reduction of individual effort when performing collectively" (Wang and Burton, 2010, p. 1), accompanied by what they describe as the 'free-rider effect' where members avoid making efforts to complete group tasks but take credit for the group work.

Research, as outlined, supports the notion that social interaction and collaboration contributes to learning. Exclusion and barriers to social interactions and collaborative experiences could therefore be considered to have a detrimental impact on learning. If sensory impaired students are denied access to collaborative elements of the learning process and as a consequence of the impairment are unable to engage then we need to investigate how this can be redressed.

Student engagement is, as with collaborative learning, seen as a significant contributor to learning (Qiu, 2019; Strauß and Rummel, 2020). Collaborative/synchronous learning is valuable, and therefore any barriers to that learning are an issue that needs to be addressed.

2.3.6 Barriers to Collaborative Learning

Barriers to collaboration can be universal to all students, specific to disabilities, or universal barriers that are exacerbated by disability. Much of the academic literature on barriers to collaboration has related to universal barriers and identified some universal issues, so this research is discussed here with the specific implications for disabled/sensory impaired students discussed in the later sections on Learning Environments and Inclusion, Accessibility and Disability. Perception of collaborative learning has a significant impact on the effectiveness of collaborative learning.

Summers and Volet looked at the relationship between group work and collaborative learning, examining engagement in high-level collaborative learning and its relationship with individuals' cognitions. They found that motivation at task onset predicted the "amount but not depth of content-related group discussion" and that interviews with participants suggested that "groups' divergent patterns of engagement with content could be related to different perceptions of the notion of collaborative learning" (Summers and Volet, 2010, p. 473). An outcome of their findings was the suggestion that divergent interactional practices may be adopted by different groups working on the same assignment, and that it "should not be assumed that group assignments will necessarily give rise to substantial engagement in productive content-related discussions" (Summers and Volet, 2010, p. 487). This highlights the need for scaffolding, or intentional group activities carefully structured to promote collaborative learning rather than simply assigning group projects.

Qureshi et al. looked at factors affecting students' learning performance through collaborative learning and engagement exploring "the ability of social factors for developing collaborative learning and engagement and whether collaborative learning and engagement mediate a link between social factors and student's learning performance." They showed social factors such as interaction with peers and teachers, social presence, and usage of social media had a positive impact on collaborative learning, student involvement, and learning performance, concluding that "overall collaborative learning and engagement with influence of social factors improve activities of students learning" (Qureshi *et al.*, 2021).

Le et al. looked at obstacles to collaborative learning from the perspectives of both teachers and students, concluding that four common obstacles to collaboration could be identified: students' lack of collaborative skills, free-riding, competence status, and friendship. Furthermore, the results showed three interrelated antecedents (goals, instruction, and assessment) that contribute to these obstacles. "Central to the antecedents is the strong focus of the teachers on the cognitive aspects of CL, which led the participating teachers to neglect the collaborative aspects of CL. These antecedents were demonstrated in the ways teachers set CL goals, provided instruction, and assessed student collaboration." (Le, Janssen and Wubbels, 2018, p. 103)

Barron looked at how collaborative interactions influenced problem-solving outcomes concluding that "both characteristics of proposals and partner responsiveness were important correlates of the uptake and documentation of correct ideas by the group" (Barron, 2003, p. 307) suggesting that quality of interaction has implications for learning.

Hilliard et al. looked at emotional responses to collaborative learning noting that "anxiety was a commonly experienced emotion among the learners and stemmed largely from the uncertainty involved in working in such contexts" (Hilliard *et al.*, 2020, p. 3). This links back to the points raised earlier on the inexperience of students when it comes to collaborative learning. The fear of what will be required both socially and practically stemming from inexperience and ignorance of the requirements of the collaborative learning process. An interesting finding from research was the difference from the perceived rather than experienced anxiety, and how the resolving of uncertainties related to the experience reduced the levels of anxiety.

Ernest et al. (2013) suggest that online collaboration is a complex process and that numerous issues come into play when exchanging ideas and co-constructing knowledge. This requires a need for scaffolding and support. They go on to suggest that many teachers have not had the chance to develop the necessary skills to provide this.

Barriers to student engagement or participation in collaborative learning can be as a result of a number of factors: experiential, sociological, economical, psychological, physical and technological barriers (McGarrigle, 2013; Fredrickson, 2015). These factors are not mutually exclusive so there are often a number of factors at play when evaluating barriers to access. This needs to be considered in the context of sensory impaired students. The barriers and reasons for their lack of engagement may not be directly associated with their sensory impairment.

Students' willingness to participate and engage is essential. Barriers to engagement can take many forms and conflicts can occur within groups relating to workload, perceived contributions, passivity or forcefulness of group members and conflicting views and opinions.

If we accept that collaborative learning is important and that social presence and interactions are an integral part of this, then how does the learning environment impact the ability to engage in collaborative learning activities? What, why, and how has CSCL changed the learning environment?

2.4 Learning Environments

Collaborative learning occurs in particular environments which create/affect the barriers that will arise for students so, as with collaborative learning, it is necessary to explore learning environments and how they impact a student's ability to engage. Initially it is useful to ask the question what is a 'learning environment'?

The Glossary of Education Reform suggests that the term learning environment "refers to the diverse physical locations, contexts, and cultures in which students learn…The term also encompasses the culture of a school or class—its presiding ethos and characteristics, including how individuals interact with and treat one another—as well as the ways in which teachers may organize an educational setting to facilitate learning…" [4]

Traditionally a learning environment was defined by a physical environment that a student is working in such as a classroom, but with the advent of online learning as an option rather than purely face-to-face learning, and the adoption of blended learning approaches in many institutions it can be interpreted to encompass much more. A learning environment may be conceptualised as a conferencing/working platform (e.g. Google classroom, blackboard collaborate, Teams, or Adobe Connect), but it can also encompass technologies, both standard technologies such as computers or handheld devices, or assistive technologies such as screen readers, voice to text translators, or specialised/customised equipment. A blended approach to learning combines face-to-face learning activities with online learning components, which can involve a mix of delivery modes, teaching approaches, and learning platforms.

Lewin's (1950) field theory stipulated the key idea of learning environment research, namely that human behaviour has two determinants: the environment and its interaction with an individual's personal characteristics. He suggested that behaviour is a function of both the person and the environment. This research focusses on synchronous online environments as particularly difficult for sensory impaired students to engage with and access so an understanding of the differences between environments, the components of each, and the nature of the learning that takes place there is essential to contextualise the research.

Online learning environments allow a flexibility in the way that interactions take place, allowing both synchronous interactions like live online tutorials and web conferencing, and asynchronous interactions such as forums, wikis, and noticeboards. This section looks at research into different

[4] https://www.edglossary.org/learning-environment/ (accessed 19/08/2022, 14:01)

experiences, comparisons and learning outcomes relating to synchronous and asynchronous learning environments, and similarly with face-to-face, online, and blended learning approaches.

> *"Online learning can be described as a method of learning delivered by using asynchronous and synchronous communications technologies; blended learning is the integration or combination of face-to-face and online learning".* (Akyol, Garrison and Ozden, 2009, p. 65).

2.4.1 Face-to-face, Online, and Blended Learning

Face-to-face learning allows teacher-student and student-student communication primarily via voice and visual communications. A teacher is able to see the students and react to body language, facial expression, and visual cues in order to assess the effectiveness of the learning process. Physical grouping of students enables them to communicate in a social community more effectively than as an online group might. Mabrito (2006) suggests that online students may have more difficulty creating the same kind of classroom communities and interactions than face-to-face students, and there is a body of research focussing on how to get students to participate in online discussions and evaluate their contributions when they do so. For example, Jin suggested using two visualisation tools, the first representing group participation and interaction between groups, and the second representing group and individual participation in order to motivate student participation, finding that the latter was effective in online participation (Jin, 2017). Zafeiriou et al. explored student perceptions of participation in collaborative learning activities by looking at "the intervening conditions affecting participation in online group work" (Zafeiriou, Baptista Nunes and Ford, 2001, p. 83). Whilst now potential quite dated, they identified these intervening conditions as familiarity with computers/software/ subject, typing skills, group size and attendance, level of interest, and technical problems. Other research suggests that the provision of an online learning community through the use of a VLE can significantly enhance transactional engagement beyond the classroom (Wdowik, 2014), in particular by allowing the teacher to be more accessible, supportive, expecting and supporting high standards, and providing challenging activities which "generated rich and meaningful interactions and promoted higher descriptive analysis". (Wdowik, 2014, p. 264).

The importance of activity design and support and use of a diverse range of technologies, both asynchronous and synchronous has been highlighted as crucial to the effectiveness of engaging students (Kebritchi, Lipschuetz and Santiague, 2017; Alshawabkeh, Woolsey and Kharbat, 2021). There is a general consensus reporting a positive relationship between online technologies, student engagement, and various learning outcomes (Chen, Lambert and Guidry, 2010; Wdowik, 2014). These aspects are discussed further in section 2.6 Sensory Impairment.

2.4.2 Synchronous and Asynchronous Learning

Whilst in a traditional face-to-face learning environment collaborative learning is by default synchronous, or ‘live’, with CSCL there is a greater variety of options available for both synchronous and asynchronous learning. Collaborative learning can not only take place via asynchronous activities (such as forums or wikis, or via specific software where projects can be designed, edited and developed collaboratively), but also during live collaborative sessions hosted on web conferencing platforms such as Zoom, Teams, and Adobe Connect.

In relation to synchronous or real time collaborative learning, studies have been conducted into the use of multiple communication channels or modalities to facilitate the learning process (Bijlani, Jayahari and Mathew, 2011). The A-VIEW project was a real-time collaborative virtual interactive e-learning environment based on a flexible framework developed by Bijlani et al. It was designed to be learner-centred and used a multi-medium approach. They suggested that the environment could support a large number of live users with its “unique architecture for collaborative environment”. This constituted a flexible model, which they ambitiously suggested could “design ambience that can cater to the needs and the tastes of a diverse group of people, spread across the globe” (Bijlani, Jayahari and Mathew, 2011, p. 18). Further suggesting that it promotes both social cohesion and economic development, and supports a more learner-centred, more active, more creative, and more inspirational approach. Whilst there are a lot of positives and potential ideas to be taken from this research (the concept of fusion of virtual reality and collaborative virtual environments and the notion of synchronous and asynchronous collaborative objects), it is ambitious in its aims and fails to effectively consider accessibility as part of its approach. The idea of synchronous collaborative objects being classified into static, dynamic and active based on their behaviour certainly has potential from a design perspective for a more flexible collaborative model, but as an untested model without proven pedagogical outcomes it needs to be appreciated more as a number of interesting potential ideas.

Kang and Shin (2015) suggest that synchronous e-learning has a considerable advantage over asynchronous e-learning in that it generates actual simultaneous interactions between instructors and learners. This has the advantage that learners can question instructors and direct and contribute to the flow of knowledge by posing live questions using visual and verbal tools such as text, graphics, and audio in these learning environments. They too suggest that these environments are advantageous for promoting communications, collaboration, and interactions between instructors and learners linking with the concepts of Communities of Inquiry.

Other studies, such as Hrastinski (2008), offer mixed results as to the effectiveness of synchronous and asynchronous learning, suggesting that combining both can result in substantially greater educational effects. He found that asynchronous discussion has a high proportion of content-related sentences, synchronous has less content-related but more related to the planning of tasks and items other than course work (particularly at the beginning of sessions) which he linked with an increase of psychological arousal and increased motivation. "Synchronous communication enables monitoring the receiver's reaction to a message, which makes the receiver more committed and motivated to read and answer the message." (Hrastinski, 2008, p. 54)

The limitations of online synchronous communication is raised by a number of studies including Mabrito who suggests that synchronous communications, because they occur in real time, are more closely akin to traditional classroom discussions but do not always have the benefit of body language or other social cues to help learners to engage (Mabrito, 2006). As an added constraint, communication often occurs more slowly where participants are communicating via text. Because communication is in real time, messages appear in the order in which they are sent, without being sorted or categorised in any way. Consequently, synchronous communication may be characterised by multiple conversational threads, not necessarily in topical sequence. Multiple topics may be addressed at the same time, and some not at all. There is the suggestion that text conversations in synchronous environments tend to be more rapid and comparable to face-to-face conversation, whereas text messages in asynchronous conferences (such as forums) more closely parallel the type of writing style one would find in formal, written language. Mabrito suggests, therefore, that asynchronous conferences tend to focus more on substantive issues and less on general conversation, unlike synchronous conferences that may give more prominence to the social aspects of interaction. With collaborative learning theory suggesting both social and pedagogical aspects are important then perhaps the combination of both forms is needed for effective online collaborative learning.

Because there are significantly fewer time constraints placed on participants in asynchronous learning environments students have more time to formulate responses to messages and may choose to navigate messages in a non-linear order. Because of these characteristics, asynchronous discussions can become a type of prewriting activity (Mabrito, 2006)

When communicating synchronously students are likely to spend more time interacting with each other. Pullen and Snow in describing their experience of more than a decade using a blend of synchronous delivery with a variety of asynchronous options and classroom instruction conclude that a "synergistic combination of the two modes [asynchronous and synchronous] with in-person instruction, designed to provide maximum flexibility to the student within the constraints of the subject, offers the best support for student learning." (Pullen and Snow, 2007, p. 137). Notions of inclusion (or possible exclusion) from this combination of modes of learning was not explored in this article, so this is something that needs to be considered.

Asynchronous methods have the advantage of making content available on-demand, independently of teacher availability. By doing so they allow students to advance at their chosen pace, independently of each other, and so are well suited to students who are motivated and disciplined. It does however mean that they lose the aspects of community and interaction (with peers and/or instructors) that a synchronous online or face-to-face setting offers. Pullen and Snow's Network Education Ware (NEW) platform "supports instructor-tutor interaction well, by either voice communication or typed questions with voice response" (Pullen and Snow, 2007, p. 142), but in doing so fails to acknowledge communications issues for DHH and BVI students.

Wang and Wang undertook a study into the challenges of building an environment where effective collaborative learning can take place that looked at the approaches and took a quantitative approach to exploring interaction in four ways: face-to-face, synchronous online, asynchronous forums, and individual work without interaction. They looked at cognitive and social presence, practice, and correlation between social and cognitive presence and practice. They concluded that synchronised activity seems to be more advantageous than asynchronous in cultivating learners' social presence and that such a connection to other members of a learning community can help with cognitive learning. However, they noted that deeper thinking and more thoughtful discussion which they believed to be entailed by asynchronous activities probably did not take place or have a significant effect in science teaching. The hypothetical connection between cognitive presence and teaching practice was not supported by the data. Being socially present may make the students feel cognitively present as well but the sense of cognitive presence may not contribute to their cognitive learning outcome. Peer interaction was seen as both important and necessary (Wang and Wang, 2021)

Design aspects of the learning environment and how they impact the effectiveness of collaborative learning is touched on by a number of studies. Akyol et al. suggest that the quality of these learning environments "depends on the design of, and students' engagement in, the learning environment" (Akyol, Garrison and Ozden, 2009, p. 66), further suggesting that poorly designed learning environments often result in unsuccessful or unsatisfactory educational experiences. They link this with the growing emphasis on building learning communities in order to increase student participation and to foster learning. Sullivan et al. looked at Multi-User Virtual Environments

(MUVEs) for collaborative learning from a design perspective. This was a comparative study of online synchronous environments featuring multiple modes of interaction, shared representations (text/images) and text only features. Shared and text only evidenced stronger learning outcomes (substantive discussion and integration of module concepts), multiple modes reported most enjoyment with the experience. "Research indicated that representational design appears to have an impact on student collaborative problem solving in chat environments. Specifically, designs that provide representational guidance that make salient epistemological aspects of the domain of interest and that balance the interface metaphors of conversation and model world analogies appear to lead to more substantive discourse of the problem being considered." (Sullivan *et al.*, 2011, p. 639). They conclude that multiple modes integrate representational guidance through a conversational metaphor, combining the design elements that appear to lead to higher levels of discussion with those that students find most enjoyable. Again, these studies by Sullivan and Akyol et al. take a broad approach to engagement, not focussing on potential barriers. It does, however, link with the concept of multiple means of engagement advocated by Universal Design for Learning, as covered in section 2.5.1.

Specific focus on environmental design for disabled students was undertaken by Rao et al., who suggest that the technology-rich environment of online learning provides greater opportunities to create accessible environments for students with Learning Disabilities (LD) and Attention Deficit Hyperactivity Disorder (ADHD). Whilst they found that for students with these cognitive disabilities, participating in online courses could remove some barriers to learning, they could also prove to be challenging due to their inherent demands in that they often require students to be self-disciplined, to have a high degree of comfort and proficiency with technology, and to be able to work without the guidance of others. (Rao, Edelen-Smith and Wailehua, 2015). The positives from this study were that students appeared favourable to the chance to interact with their peers and teacher and appreciated the flexibility and availability of online materials. Challenges noted by students included issues with communications and lack of clarity about directions. Another aspect that came out of this study was that the faculty were not aware of students' personal profiles and so did not know who would be enrolled and what disabilities they might have before the course began. This led to the emphasis on the proactive use of universal design frameworks by course instructors and designers, reemphasising the fact that activity design is crucial for both collaborative and accessible learning.

In summary, online learning environments provide many different ways for students to collaborate, both synchronously and asynchronously. The optimum learning environment appears to be one that incorporates both forms and has a focus on effective and adaptive activity and content design.

2.5 Inclusion, Accessibility, and Disability

Having considered the importance of collaborative learning and the implications of different learning environments it is then necessary to consider how some students might be excluded from this experience. A truly inclusive learning environment has to be one that does not present barriers to any student.

This section looks at inclusion, accessibility, and disability in the educational context. What these terms mean, how they apply in Higher Education, and the existing body of research in improving access and inclusion for disabled students, and specifically BVI or DHH students. These three concepts are all at play in considering barriers to participation in online synchronous activities for sensory impaired students and so these terms require some clarification.

Definitions

Inclusion: Inclusion can be interpreted as "a broad range of socio-technical approaches that enable the autonomy and participation of all learners, while lowering and removing barriers that impede specific groups". Inclusion "values and promotes diversity and equality of opportunity, particularly with regard to disability, gender, age and ethnicity." (The Open University, Accessed: 29/09/22 09:32)

Disability: The Equality Act 2010 states "A person (P) has a disability if — (a) P has a physical or mental impairment, and (b) the impairment has a substantial and long-term adverse effect on P's ability to carry out normal day-to-day activities." (*Equality Act 2010*, Accessed: 31/05/22 18:10)

Accessibility: The UK government website suggests that "accessibility means that disabled people are not excluded from using something on the basis of experiencing a disability that people can do what they need to do in a similar amount of time and effort as someone that does not have a disability. It means that people are empowered, can be independent, and will not be frustrated by something that is poorly designed or implemented."[5]

So, in the educational context, inclusion is about lowering and removing barriers to learning for all excluded groups, accessibility is about ensuring that disabled students are not excluded from studying and related activities, and disability (or being defined as a disabled student) relates to having a physical or mental impairment that impacts the ability to study. These somewhat simplistic definitions are explored further in order to contextualise the potential barriers to student learning

[5] https://accessibility.blog.gov.uk/2016/05/16/what-we-mean-when-we-talk-about-accessibility-2/ (Accessed: 29/09/2022 09:30)

and how these impact on their ability to collaborate and to engage with peers in different learning environments.

Inclusion

Whilst the OU inclusion statement above highlights four specific areas (disability, gender, age, and ethnicity), the prevalent approach to inclusion at the moment is one where the focus has moved away from identifying specific sub-groups of students towards the structure, processes and practices within the institution which create barriers to equitable experiences. This can be seen within global institutions such as the United Nations whose goals include UN goal 4 which has the aim to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" stating that "It is inspired by a humanistic vision of education and development based on human rights and dignity; social justice; inclusion; protection; cultural, linguistic and ethnic diversity; and shared responsibility and accountability" stating that they "commit to addressing all forms of exclusion and marginalization, disparities and inequalities in access, participation and learning outcomes." (United Nations, Accessed: 29/09/2022 09:34)

Focusing more specifically on higher education, the Higher Education Authority (HEA) report on developing an inclusive culture in HE (Wray, 2013) gives an account of a programme of activity to promote inclusive teaching and learning with a vision to support HE institutions in the creation of an inclusive learning and teaching culture that "enables all students to develop academically, professionally and personally to fulfil their potential" (Wray, 2013, p. 3). This report shows the spectrum of approaches to inclusion with one end of the spectrum focussing on specific groups of students that might be excluded (e.g. age, gender, disability, ethnicity) and the other a more generic or all-encompassing approach with an understanding that in order to be fully inclusive HE providers need to ensure that all students are included and experience equitable participation reflecting the shift towards a more embedded approach to equality, diversity and inclusion.

How does this then impact on research which focuses on one of these sub-groups? I would suggest that to enable this equitable experience it is necessary to understand the factors that make the access inequitable. In order to do this the perspectives of disabled students need to be understood to see where the structure, processes and practices within the institution fail.

In the context of this research, the inclusiveness of collaborative learning events has to be seen not just in the context of the learning event itself but in the ability to access and participate in that event, and in the resulting learning outcomes.

Accessibility

Accessibility in education often focuses on legal requirements. As universities in the UK receive public funding, then for their online website and mobile applications the *Public Sector Bodies (Websites and Mobile Applications) Accessibility Regulations 2018* applies (Gov.uk, no date). An "accessibility requirement" means the requirement to make a website or mobile application accessible by making it "perceivable, operable, understandable and robust." These regulations do not apply to "live time-based media" which is important in considering live online learning events as the legal requirements do not apply. This suggests that perhaps less focus or emphasis is placed on making these learning environments accessible. Accessibility in HE institutions often focusses on buildings (where it is usually taken to mean that someone with a mobility impairment/wheelchair user can get into and use the building) or website and learning materials (where it is often understood to mean someone that has a sensory impairment is able to use it).

In practice, accessibility online generally focuses on web content: adhering to W3C standard[6] such as ensuring alternative text is provided for images, transcripts for audio/video, and making functionality available from a keyboard. These are all, of course, important in accessibility but live synchronous events are not static content and collaborative activities do not have fixed, prescribed content and navigation, so it is essential for other aspects of accessibility to be explored.

The other problem with approaches to accessibility is that they are often confused with usability. Usability and accessibility are terms which have, often incorrectly, been used interchangeably. Whilst they are linked, they are distinct terms and can be at conflict with one another. Possible distinctions see usability defined as "the effectiveness, efficiency and satisfaction with which users can achieve specified learning (or learning-related) goals" and accessibility determined by "the flexibility of the e-learning system or learning resource to meet the needs and preferences of all users" (Cooper, Colwell and Jelfs, 2007, p. 232). These needs may arise from their environment, the tools they use or a disability in the conventional sense. This differential between efficiency and flexibility in relation to the two terms suggests that the lower the level of accessibility the less usability issues and conversely the more accessible for disabled users the more usability issues. In general, this seems to be the case but there is a level of complexity within disabled users' needs that can cause some conflicting accessibility needs. Whilst web standards are often used as a gauge of both usability and accessibility this is just one aspect of the online environment and does not encompass all aspects.

[6] https://www.w3.org/standards/webdesign/accessibility (Accessed: 29/09/2022 09:07)

Muwanguzi and Lin, (2010), talking of blind students, suggest that whilst web interface designers often try to follow W3C accessibility and usability guidelines, emphasis is placed on universal accessibility at the expense of usability concerns for people with disabilities. Similarly, although an old article, Leporini and Paterno observed that "often when designers consider people with special needs, they tend to address only accessibility issues, and ignore those regarding usability… yet even if a site is in principle accessible because it completely complies with technical accessibility standards, it can still be so hard to use for people with disabilities that they may not succeed in reaching their goals" (Leporini and Paternó, 2004, p. 57)

This notion of the importance of an institutional commitment is raised again by Cooper et al., who acknowledge that if accessibility is applied from the start and at all levels then this provides the most effective approach: "It is invariably the case that addressing accessibility in the development phase is far more effective than any retrospective accessibility response and is usually less costly and better pedagogically than the provision of an alternative but comparable learning experience for disabled students." (Cooper, Colwell and Jelfs, 2007, p. 233). They also return to the necessity to take a more holistic approach to learning arguing that "accessibility, usability and pedagogic issues are all interrelated in an e-learning context. Accessibility and usability issues need to be addressed throughout a project's lifecycle to ensure its developments are subsequently adopted in educational delivery" (Cooper, Colwell and Jelfs, 2007, p. 243). They highlight how this institutional commitment has to involve all stakeholders, plus the connection between accessibility and usability, suggesting this contributes to the effectiveness of the learning.

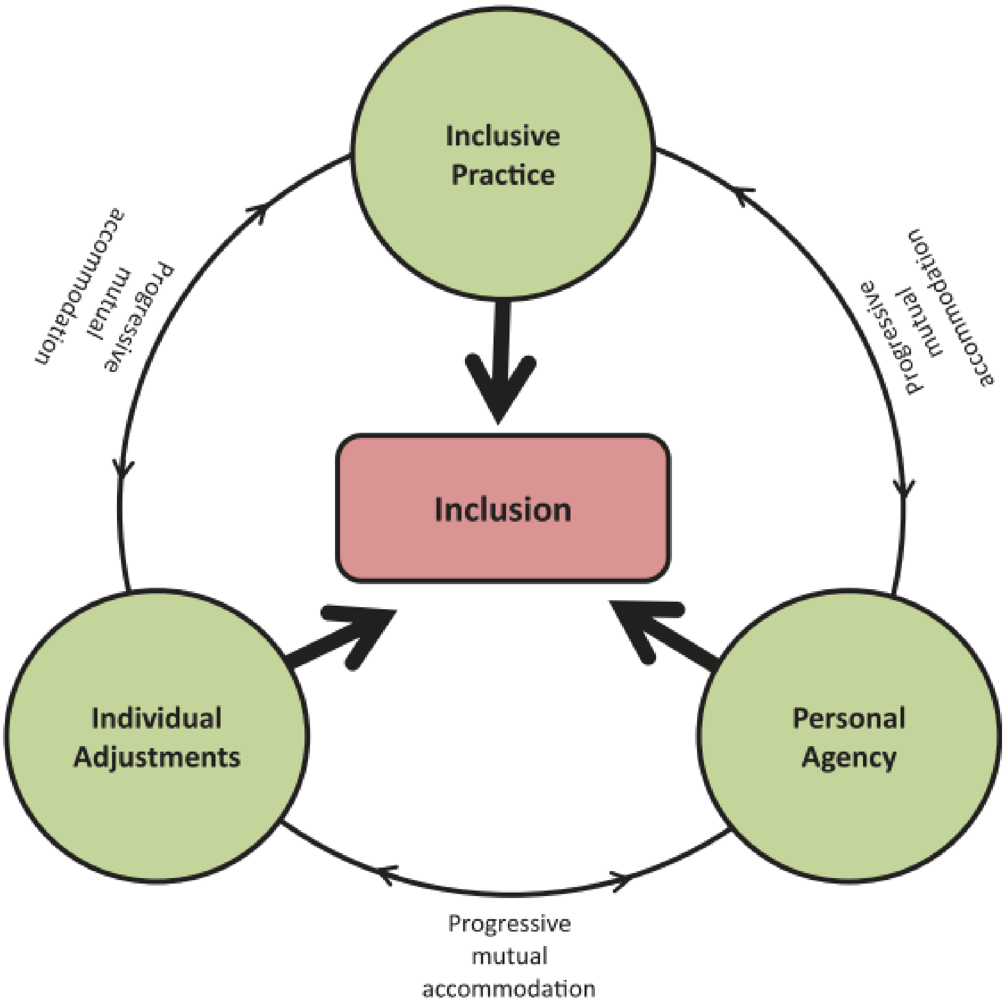
In their guidelines for accessible online learning Rogers-Shaw et al look at redesigning existing environments (Rogers-Shaw, Carr-Chellman and Choi, 2018). They recognised that students need options for accessing the course content. Although visual representations can enhance learning for some students, for others it does not and similarly it is important to recognize that merely adding a text-reader function or closed captioning a video is not a significant way to address disability and diversity.

> *"Organizations that deliver online learning must be strategic and holistic in their accessibility approach, ensuring all necessary structures are in place to support accessible and equitable experiences for learners with disabilities. Responsibility for accessibility must be distributed appropriately across all stakeholder groups."*
> (Sloan, Horton and Gregory, 2016, p. 1)

Usability and accessibility are concepts that need addressing because of the complex relationship between the two. Increased usability does not necessarily mean increased accessibility.

Realistically there is going to be a need for adjustments and changes over time, however committed an institution is to inclusive practice and accessibility. The needs of individuals are diverse and it is necessary to acknowledge this. Hewett et al. looked at balancing inclusive design with adjustments and personal agency suggesting that students need to be empowered within educational contexts to develop personal agency and to work with institutions to develop strategies of support in the form of "progressive mutual accommodations". They utilised a model of inclusion, balancing inclusive design, individual adjustments, and individual agency.

Figure 1 Model of inclusion (Hewett *et al.*, 2020)



This acknowledges that inclusive practice implemented by an institution is not enough in isolation but needs to incorporate the "important contribution of the learner to his or her experience" so that "institutions might work with students to promote inclusive learning" (Hewett *et al.*, 2020, p. 755). This acknowledgement of the importance of the role of the student in achieving accessibility within an institution was supported by Coughlan et al. who suggest that “accessibility cannot be fully achieved through adherence to technical guidelines, and must include processes that take account of the diverse contexts and needs of individuals.” (Coughlan, Ullmann and Lister, 2017, p. 1). They suggest an important aspect of this is to understand and utilise feedback from disabled users and that their analysis suggests that “procedural themes, such as changes to the individual over time, and their experiences of interpersonal interactions, provide key examples of areas where feedback can lead to insight for the improvement of accessibility.”

Inclusion and accessibility with respect to disability needs some understanding of the relationship and history of disability and HE.

Disability

Disability studies is a broad and encompassing discipline and perspectives on disability have shifted over the years. It is impossible to cover all aspects in this literature review, so I am focussing on understanding the different models of disability and the approach and context adopted for this research.

Disability has historically been defined by various models of disability, primarily: medical, charitable, social, and identity models.

The medical model of disability views the disability as a ‘defect’ that needs to be fixed or cured. It perceives disability as an illness and assumes that those affected are unhappy with their inability to function as others do. This model focused on trying to make disabled people ‘normal’, trying to fix the perceived problem with the individual rather than to address why the individual was encountering problems in their daily life. The medical model takes a clinical look at disability and sees the disability in terms of disease or abnormality. The charity model is essentially an offshoot of this which emphasises the personal ‘tragedy’ of disability, often based on understanding disability as something that should be ‘cured’. This has historically been associated with perpetuating negative stereotypes. The social model, now more widely adopted, places the problems within society rather than the individual: disability is a result of society’s inability to adapt. The social model describes disability in relation to the environment of the person with the disability. Instead of focusing on the function of the body, the social model identifies barriers in the environment, such as derogatory attitudes, social isolation, or physical exclusion of people with disabilities. Disability as an identity model is closely related to the social model of disability yet with a fundamental difference in emphasis: this model shares the social model's understanding that the experience of disability is socially constructed, but differs to the extent that it 'claims disability as a positive identity'. (Accessibility.com, Accessed: 29/09/2022 09:37). This social model of disability has parallels to the all-encompassing approach to inclusion outlined above and moves the focus of understanding around disability away from individuals and the experiences of their individual impairments towards the disabling barriers within the social world.

Although the medical model has ceded to the social model in most contexts, in education it is still evident in many schemes where a student has to ‘prove’ a need based on their medical ‘deficiencies’. This can be stigmatising and demoralising for many disabled students. There remains a dichotomy in most HE institutions between legal and procedural requirements which often require an approach that is closer to the medical model of disability, and the academic, pedagogical, and practical approaches which tend more to the social model of disability.

Bickenbach et al. provide a review and critique of models of disability which, although more than 20 years old, provides an insight into the development of these models. Even then, it was acknowledged that the social model of disability is ‘universally accepted’. They do, however, argue “that universalism as a model for theory development, research and advocacy serves disabled persons more effectively than a civil rights or 'minority group' approach.” (Bickenbach *et al.*, 1999)

Many charities have moved away from the charity model towards a social model. UK disability equality charity Scope’s current statement states:

> *“Disability is caused by the way society is organised, rather than by a person’s impairment or difference. It looks at the ways of removing barriers that restrict life choices for disabled people. When barriers are removed, disabled people can be independent and equal in society, with choice and control over their own lives”*[7]

The social model considers the individual and the environment and considers the skills, abilities of the person and the environments capacity to adapt. Coombs asserted that “disability is not so much an attribute of a person as it is a mismatch between a particular person and a particular environment” (Coombs, 2000).

The core arguments of the social model were formalised in a statement of the Union of the Physically Impaired Against Segregations in a 1976 statement. These arguments were developed and extended to all disabilities mainly by Mike Oliver. Oliver, a pioneer of the social model of disability in the 1980s, based the model on his belief that it is not individual limitations that are the cause of the problem, rather it is society’s failure to provide appropriate services and adequately

[7] https://www.scope.org.uk/about-us/social-model-of-disability/ (Accessed 05/09/2022 10:26)

ensure that the needs of disabled people are considered (Oliver, 2013). The model gained steam over the next three decades as society shifted from trying to 'fix' an individual with a disability and instead creating best practices for equity, like universal design and social inclusivity. Though the social model has given rise to outcomes like the Americans with Disabilities Act, it is not without conflict. Anastasiou and Kauffman feel the social model paints disability with a broad brush, ignoring individual differences and instead lumping together all disabilities into one demographic category with a standardised set of solutions. They assert that there are variations within each category of disability that should influence the way society responds. Within the deaf community, for example, there are conflicting viewpoints on the value of hearing aids and cochlear implants, teaching deaf children to speak versus teaching them sign language and whether it is better for television shows to provide closed-captioning or a picture-in-picture box with sign language interpreters. They also acknowledge that not all disabled people perceive their disabilities the same way. They condense the arguments of the social model into five interconnected themes:

- There is a distinction between impairment and disability
- Impairment refers to physical/bodily disfunction, whereas disability refers to social organisation
- Disability is not a product of bodily pathology, but of specific social and economic structures
- Disabled people are an oppressed social group
- Disability is not a matter of personal tragedy. (Anastasiou and Kauffman, 2013)

For Oliver (1990), impairment refers to the loss or lack of some functioning part (organ or mechanism) of the body. Disability refers to a society that discriminates, disadvantages and excludes people with impairments as it does not make appropriate accommodations and gives preference to those without impairments. Anastasiou and Kauffman argue that as a consequence, by neglecting or denying the underlying biological conditions of people with disabilities they leave out a big part of their existence: "biologically naked and only subjected to social values and roles" (Anastasiou and Kauffman, 2013). They go on to talk about the neutralisation of disability, how disabilities themselves are not neutral features as it is not just a social construct such as race or ethnicity as that not all differences are created equal. Social justice is not found in responding to all differences as if they were equal, as if the remedy for one is the remedy for all. When biological or intrinsic characteristics are neglected as a reality, disability becomes a neutral thing. This neutralisation of disability, disconnecting it from body, brain and mind-related conditions, in turn allows proponents of a social model to give their theoretical constructs complete autonomy, to argue as if people were empty of biological features. They ask the question "Assuming that we have an ideal, perfect, caring society, will disabilities no longer exist? ... the social model of disability represents an extreme form of cultural determinism, because it denies the role of biology and is thus opposed to the actual experience of many people with disabilities." (Anastasiou and Kauffman, 2013)

Whilst models enable a perspective, this does not necessarily imply that there is any 'correct' model. The aims and approach of this research are most aligned with the social model and the capacity of the environments to adapt to students' needs but acknowledging aspects of the identity model. The disabled student needs to have a voice in the research, the varying characteristics of the sensory impairment within the student population has to be acknowledged, and it will be important that they themselves feel comfortable when discussing disability.

So how is disability defined within the educational context? The IMS (Instructional Management System) Global Learning Consortium suggests that accessible systems should:

> *"adjust the user interface of the learning environment, locate needed resources and adjust the properties of the resources to match the needs and preferences of the user."*[8]

defining disability as "a mismatch between the needs of the learner and the education offered." This emphasises the point that disability should not be thought of as a personal trait but as an artefact of the relationship between the learner and the learning environment or education delivery. Accessibility, under the IMS definition, is the ability of the learning environment to adjust to the needs of all learners and is determined by the flexibility of the education environment (presentation, control methods, access modality, and learner supports) and the availability of adequate alterative-but-equivalent content and activities. They emphasise that the needs and preferences of a user may arise from the context or environment the user is in, which again links us up with the differences in learning environments raising distinct barriers.

This is a definition that has been re-utilised by other researchers such as Jane Seale and Martyn Cooper, which focusses not on the disabled learner but on the ability of the institution to have sufficient flexibility and motivation to adjust. Douce et al., (2010) suggest that "The presence of particular impairment may reduce a person's ability to participate within a range of tasks or activities" (Douce, Porch and Cooper, 2010, p. 4).

[8] https://imsglobal.org/home (Accessed: 29/09/2022 09:10)

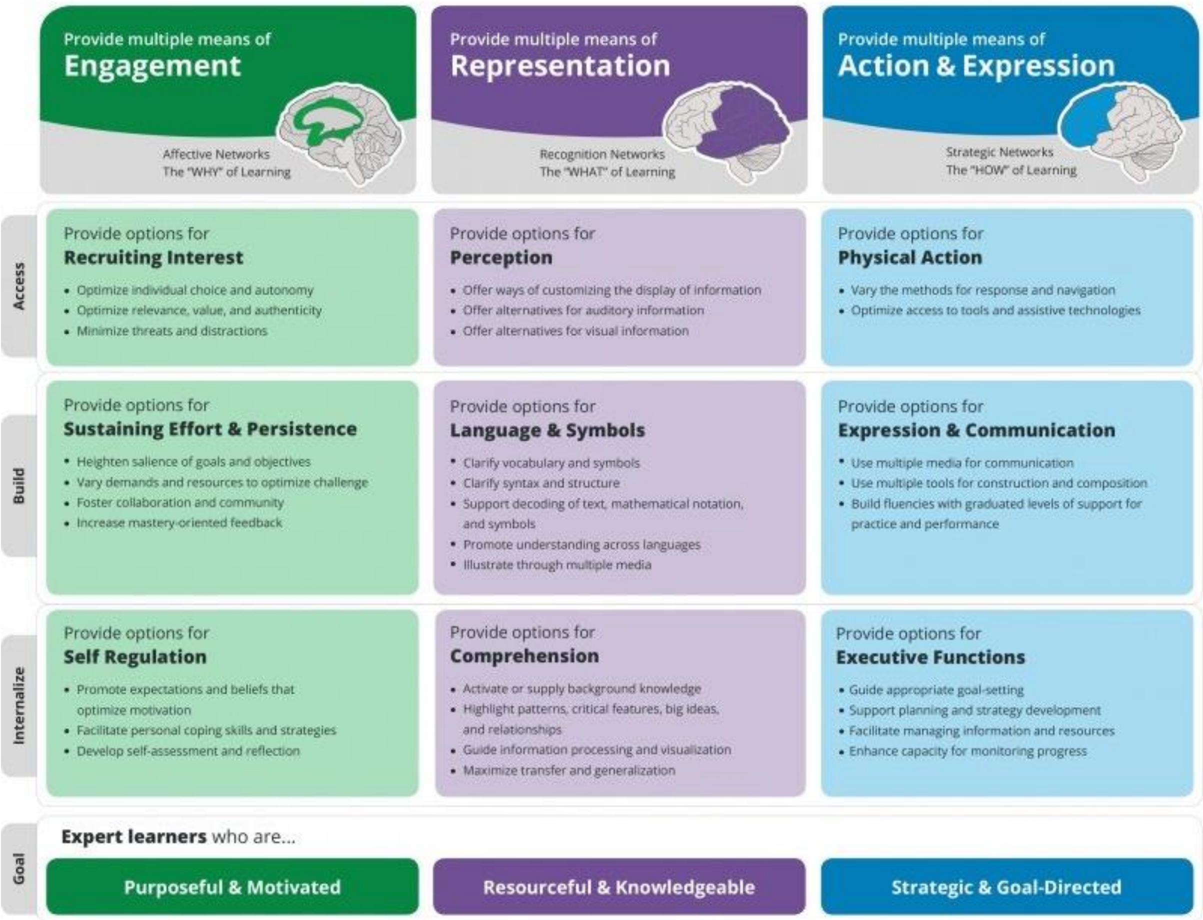
So, we have these two concepts, the first the need for a flexible educational environment, and the second a requirement to understand the impact of impairment on a student's ability to participate.

2.5.1 Universal Design

Research seems to suggest that some barriers are a consequence of failing to address accessibility at an early stage. Adoption of Universal Design (UD) principles has been proposed as a way to address these barriers. This is often shown as a 'golden bullet' approach, which has the potential to resolve all barriers, but although UD should be considered proactively during the process of developing a course and is certainly an approach that has the potential to reduce barriers, there is often more complexity than is presented.

There are three established Universal Design based educational frameworks: Universal Design for Learning (UDL), Universal Instructional Design (UID), and Universal Design of Instruction (UDI). UDL was developed via the National Centre on Universal Design for Learning and works on the principles of 'multiple means' of the core areas of representation, action and expression, and engagement.

Figure 2 Universal Design for Learning Guidelines



https://udlguidelines.cast.org/?utm_source=castsite&lutm_medium=web&utm_campaign=none&utm_content=aboutudl

Their approach was to acknowledge that students have very diverse needs and education has to be designed from the start to meet these needs. The intention of the approach is to reduce barriers and maximise learning for all students. By Universal they mean a curriculum that is understood by everyone, providing genuine learning opportunities for each student. Taking a neurological approach, they talk about the why, what, and how of learning relating them to affective, recognition, and strategic neural networks respectively. They map each of these networks to access, build, and internalise phases, suggesting multiple options for each network at each phase. The goal of the process is to produce 'expert learners' who are purposeful and motivated (why), resourceful and knowledgeable (what), and strategic and goal-directed (how).

The core principles of UID were proposed by the PASS IT (Pedagogy and Student Services for Institutional Transformation) Project funded by the US department of education (Higbee, Goff and Minnesota Univ., 2008). These principles are:

- Creating welcoming classrooms
- Determining essential components of a course
- Communicating clear expectations
- Providing timely and constructive feedback
- Exploring use of natural supports for learning, including technology
- Designing teaching methods that consider diverse learning styles, abilities, ways of knowing, and previous experience and background
- Creating multiple ways for students to demonstrate their knowledge
- Promoting interaction among and between faculty and students.

The concept of 'learning styles' is one that is now widely discredited and studies show that presenting material according to supported learning styles does not lead to improvements in what students learn (Pashler *et al.*, 2009; Cuevas, 2015), furthermore there is no consensus on what learning styles might exist. However, the notions of inclusivity and diversity remain significant, and there is a crossover in the concepts of multiple ways of demonstrating, and in terms of engagement, the importance of promoting interaction between participants in the educational experience.

Burgstahler discussing UDI suggested the core eight elements for effective instruction: class climate, interaction, physical environments and products, delivery methods, information resources and technology, feedback, assessment, and accommodation (Burgstahler, 2021) She recognised the urgent need for the design and delivery of online content and engagement mechanisms that are equitable for all as a consequence of the COVID-19 pandemic.

UDL is often promoted as an inclusive teaching methodology for supporting all students within diverse contemporary classrooms. This is achieved by proactively planning to the edges of a classroom by thinking of all the potential needs of students. But how effective is UDL? What evidence is there to suggest that it results in better learning outcomes?

A number of studies have applied these UD frameworks and principles to evaluate their effectiveness. Rao et al. (2015) record how one instructor applied UD principles to her course. They looked at both synchronous and asynchronous elements and UID and UDL. The article looked at perceptions but did not examine efficacy of strategies to help students in meeting course objectives or increasing students' understanding or knowledge of course content. It raised the issue that many tutors highlight about the increased workload required to plan, produce materials, and develop learning environments that apply these principles but suggests that "although the integration of UD elements can take time and effort on the part of the instructor when a course is being developed for the first time, the proactive and flexible nature of these supports allows them to be reused and repurposed as the instructor teaches future iterations of the course" (Rao, Edelen-Smith and Wailehua, 2015, p. 51). This may be the case but it raises issues around an institution's commitment to implementation of these principles and the investment in the initial time and effort required. It leads back to the concepts of a 'joined up' approach to both UD and collaborative learning in that it is most effective when all participants and stakeholders commit to the process. It also raises the requirement for staff to have adequate training in how to apply these principles, noting that "Instructors often require additional support to learn how to create flexible resources, learn how to use emerging technologies and to work with their Disabilities Student Services offices to integrate specific support that students might need." The increasing importance of UD is related to diversity and the changing student population "the need to engage in a purposeful design process to create engaging and supportive online environments is becoming increasingly necessary as student diversity increases on campus."

Boysen highlighted what he saw as the "troubling similarities between Learning Styles and Universal Design for Learning" (Boysen, 2021). He suggests that "UDL shares problematic similarities in theory, operationalization, and research with the discredited concept of learning styles" these being that no strong research evidence exists that either approach increases learning, that research on both approaches is "hampered by inadequate operationalization" and that both learning styles and UDL "emphasize diversity in learning over universal learning principles and hypothesize that matching instruction to students' unique way of learning leads to increased learning" (Boysen, 2021, p. 2). The core of his argument is a lack of empirical evidence for the effectiveness of UDL in increasing learning, stating that justifications for both UDL and learning style approaches rely on “overgeneralizations of neuroscience research” and that although UDL shows promise as an educational framework, its proponents need to “learn from the flaws of learning styles and follow a more scientifically sound path forward”. This is a view echoed by Murphy who suggests “While the rhetoric is promising, no rigorous published research has demonstrated any improvement in an education intervention designed with UDL principles in mind. Furthermore, the community of practice around UDL appears to be hostile to questions around the rigor of analysis used to promote UDL interventions. Studies of UDL approaches do not follow best practices in terms of research design, and often solicit anecdotes rather than testing the effectiveness of the approach”. Murphy concludes that “the only evidence-based conclusion that can be made about UDL is that further study is required, as its core claims remain unproven” (Murphy, 2021, p. 7)

Capp explored this notion of evidence too when he undertook a meta-analysis of UDL on “empirical research, containing pre- and post-testing, published in peer-reviewed journals between 2013 and 2016 (N = 18).” Results from this analysis suggested that “UDL is an effective teaching methodology for improving the learning process for all students” but that “the impact on educational outcomes has not been demonstrated.” So whilst he made the assertion on the effectiveness of UDL he acknowledged that “these results may be due to the lack of empirical evidence involving a pre- and post-test methodology” concluding that future research is needed to further examine its impact on the learning process (Capp, 2017, p. 791).

The linkage between UDL and learning environments has been explored. An important element in applying UDL is that it begins with course design, rather than trying to meet the needs of diverse students only when problems develop, and this course design applies to environments as well as content. In practice it is often the case that UDL principles need to be applied to existing environments and online courses. Implementation of UDL in institutions is often problematic because it requires commitment from all stakeholders in the institution as well as a collective, embedded commitment.

Research has been undertaken in the area of evaluating accessibility of VLEs from the perspective of UDL and diminishing accessibility issues. Park et al., (2016) tested three Massive Open Online Courses (MOOC) platforms (Coursera, edX and Khan Academy) with the UDL principles and then conducted a user study for four students with visual impairment. Their studies concluded that the MOOCs met just over half of the 40 UDL categories. MOOCs and UDL were also considered by Iniesto and Hillaire, (2021); Iniesto et al., (2019) and Coughlan et al. (2016) who suggested that Open Educational Resources and MOOCs “offer new opportunities for learners who face limitations of cost, time or distance, entry requirements, or gender. However, this new educational paradigm has not developed with an inherent capacity to attend to the needs of disabled students." (Coughlan *et al.*, 2016, p. 1).

Moorefield-Lang came up with a list of ten recommendations for best practice when creating innovative, accessible online learning environments. (Moorefield-Lang, Copeland and Haynes, 2016). Although this was context specific (University of South Caroline School of Library and Information Science), they bring together many of the principles discussed and are applicable in a wider context. They suggest: applying UDL principles, orientation and/or step-by-step access instructions, consistency and repetition, multiple material formats, accessibility checks, transcripts and closed captions for all lectures and synchronous or asynchronous interactions with students, accessible font types and sizes, maintenance of ongoing one-to-one and group communications with students, and monitoring and adjustment.

There is an understanding arising from the inclusion and accessibility research, and in line with the social model of disability, that learning environments need to adjust to the needs of all learners. In order to be accessible, the education environment has to be flexible and provide alternative means of access:

> *"Accessibility is determined by the flexibility of the education environment and the availability of adequate alternative-but-equivalent content and activities."*
> (Seale, 2014, p. 9)

2.5.2 Accessibility in HE

Seale (2014), looked at research and practice in relation to the accessibility of e-learning for disabled students in higher education. She states as an aim to discover what "we do and we do not know about making e-learning accessible for disabled students in higher education" and takes the approach of looking at contextualising, surveying, critiquing and re-imagining the 'scene'. In doing so she takes a macro perspective on accessibility advocating the notion that accessibility has to be institution-wide, embedded as part of the culture and is only possible with the cooperation of all stakeholders. In Part IV - the re-imagining section – she looks at research and practice, and institutional, community and individual responses to accessibility. At the core is the concept that research needs to give voice to disabled students. She talks about the need to breach boundaries between stakeholder communities:

> *"The idea that connections need to be made between the different stakeholder communities that make up the constellation of accessible e-learning practice is*

> *compelling in that there is growing evidence that these stakeholder communities need to work together and that the boundaries between the communities are not unbreachable."* (Seale, 2014, p282)

The involvement of all stakeholders in accessibility and inclusion in education is deemed crucial by much of the aforementioned research. Unless it is embedded at all stages of the process, and dialogue is opened up between the stakeholders, then any contribution to accessibility is limited.

How involved a student is in the collaborative process can be influenced by a number of factors including previous learning experience, individual difference, use of technology in education and environmental factors. We know that there is often a reluctance on the part of students to fully participate, often preferring to take a passive role. For people with sensory impairment the choices available to them, and the options to collaborate, may be further limited.

In terms of student engagement, the emphasis seems to be on the techniques and strategies of getting students involved rather than looking at the practical and psychological barriers to their involvement that inhibit participation in the first place.

Whilst in a general context the use of a multi-media format may provide more options for engagement, in a collaborative environment, particularly if 'live', it may provide specific problems for students with sensory impairments.

Despite significant progress in access to post-compulsory education for students with sensory impairment, institutions are still struggling with how best to support them. The use of e-learning and information technologies has, paradoxically, had a negative impact on access to course materials and other resources hosted online for students with disabilities, particularly those individuals with sensory impairments (Bühler and Fisseler, 2007).

It is important that accessibility should be 'built-in' to VLEs (Cooper et al., 2007). The use of technology as a tool to facilitate this and breach boundaries holds great possibilities. Advances in the tools and technologies utilised by VLEs (multi-media, interaction design, tracking and mining user activity, voice-to-text and text-to-voice, and Artificial Intelligence) lead me to believe that these problems now have the potential to be solvable. Seale's research supports this.

2.6 Sensory Impairment

This section covers research relating to online learning for sensory impaired students. It reviews existing research in sensory impairment in education and places it alongside collaborative learning, learning environments, and inclusion, accessibility and disability considerations.

Before focusing on sensory impairment research, the choice of terminology requires an explanation. 'Sensory impairment' or 'sensory loss' are umbrella terms used to describe loss of the distance senses i.e. of sight and hearing and covers a multitude of experiences. Understanding how the terminology is used and interpreted in research is essential for comparative studies and to place this research in context and understand it in relation to other studies.

2.6.1 Hearing

Hearing impairment includes hard of hearing people with a mild, moderate, or severe hearing loss. It also covers *deafened* people: those who were born with hearing and have become severely or profoundly deaf after learning speech. In addition, there are people born with profound hearing loss. The word deaf (lower case d) is used to describe or identify anyone who has a severe hearing problem. Sometimes it is used to refer to people who are severely hard of hearing too. Deaf with a capital D is used to refer to people who have been deaf all their lives, or since before they started to learn to talk. They are pre-lingually deaf. It is an important distinction, because Deaf people tend to communicate in sign language as their first language. For most Deaf people English is a second language and understanding complicated messages in English can be a problem.

The term "hearing impaired" is often used to describe people with any degree of hearing loss, from mild to profound, including those who are deaf and those who are hard of hearing. The choice of the term Deaf/Hard of Hearing (DHH) is used to include both Deaf students and those with a hearing impairment that affects their engagement online.

2.6.2 Sight

Visual impairment is the term used to describe a loss of sight that cannot be corrected using glasses or contact lenses. Blind people have a severe sight impairment, partially sighted people have some vision which is impaired or reduced. Only around 4% of blind people have no vision at all[9], the majority have a combination of very limited or restricted fields of vision. Visual impairment and blindness is usually based on someone's ability to see detail (acuity) or on a diameter of a visual field. Visual acuity generally refers to the clarity of vision, someone's ability to recognise small

[9] https://www.rnib.org.uk (Accessed: 29/09/2022 09:15)

details with precision. The diameter, or field of vision, is the area that can be seen when focussed on a fixed point. Visual impairment can also cover colour blindness – seeing colours differently from most people and being unable to distinguish between certain colours. The most common type of colour blindness makes it hard to distinguish between red and green. Less common is blue-yellow colour blindness, but some people have complete colour blindness (monochromacy) which is the inability to see colours at all, just light intensity, which can also make seeing clearly difficult and cause a sensitivity to light. The term Blind/Visually Impaired (BVI) is used to include any visual impairment that affects their engagement online.

2.6.3 Deafblind/ Dual sensory impairment

People who have a severe degree of visual and hearing impairment may be described as Deafblind or having dual sensory impairment. Some people may be deafblind from birth, others may be born deaf or hard of hearing and become blind or visually impaired later in life, or the reverse may be the case. This will have a direct impact on the method of communication preferred.

My choice of terminology was based on two factors: acceptable terminology for the user groups, and how the definition is relevant to the research. When students have an attenuation or reduction of operation of a functional sense such as hearing or sight this has a significant impact on their ability to participate within the educational environment and to interact with their peers and teachers socially and productively. Because the research was focusing on whether students with sensory impairment were experiencing barriers to collaborative engagement participants were classified as Blind/Visually Impaired or Deaf/Hard of Hearing when the sensory impairment could have an impact on their ability to participate in collaborative learning and engage in online synchronous events. Those with dual sensory impairment are classified as BVI and DHH as they are included in both comparative groups for analysis, but also require some discussion as a group in their own right.

As considered earlier when covering the concepts of inclusion, accessibility, and disability, there is an argument that accessibility should not be broken down into different 'impairments' or accessibility issues, and that focussing on one aspect of accessibility (sensory impairment) can be counterproductive when applied in a wider context i.e. accessibility in general. There is a counterargument that one might want to break it down into different disabilities precisely because disabilities are very different in nature and create different barriers. In practice students with disabilities may have complex and differing needs and require different adjustments. Hearing and vision impairments in themselves are complex and differ covering a range of experiences.

One of the reasons for choosing both hearing and sight impairments was that solutions that include accommodations for one sensory impairment may have a detrimental effect on the other: providing voice over is not useful for a student with hearing impairment and subtitling is not useful for a student with sight impairment. Considering usage of all of the senses in enabling effective communication is important.

2.6.4 Sensory Impairment Research

Historical research on e-learning suggests a number of issues that students with sensory deprivation encounter when using online material. These often centre on materials that they are unable to read or consume, or discussions and forums in which they are unable to participate.

Much of the research around inclusion and sensory impairment in education focusses on children in schools rather than adults in further or higher education. Similarly, the focus is often on Deaf rather than DHH, or Blind rather than BVI. Whilst there is a body of research relating to making online education accessible for disabled students there is very little that focusses directly on online synchronous collaborative work and the specific problems this presents. The research covered in this section covers papers and studies that are relevant to aspects of this specific context and is broadly collected into studies focussing on DHH students in the first section and BVI students in the second but includes general research on inclusion online for broader disability categories.

There are not many systematic reviews in the field of sensory impairment. Rix et al. undertook participatory research involving people with sensory impairments and/or intellectual impairments. However, this was "dominated by work with people identified with learning difficulties" and whilst it raised some interesting points about the research being dominated by speech, the use of imagery, and the control of funders and academics over the research, it does not add much relating to sensory impairment other than to highlight the lack of research in the area. (Rix *et al.*, 2020)

DHH

Much of the research focus on DHH students has primarily centred around the education of Deaf children, or communication problems relating to interpretation. More perhaps than other disabilities there is a distinction between the use of the word deaf to describe someone with a hearing problem (sometimes inclusive of hard of hearing), and Deaf (with a capital D) which generally refers to people who have been deaf all of their lives (or pre-lingually deaf). Deaf people tend to communicate in sign language as their first language. This means that for most Deaf people English is a second language whereas for most deaf people English is a first language (which may be supported by signing). There is also a perceived barrier between these two groups (deaf/HH and Deaf) who may experience isolation within the HE environment from both their hearing peers and the 'other' DHH student group.

In terms of exclusion and barriers to participation in collaborative activities then for the purposes of this research any level of hearing loss which negatively affects a student's ability to participate has been considered. In this respect research into both Deaf and Hard of Hearing (DHH) was of interest to this study. At the core of this is the ability to communicate and engage with peers, tutors, and the learning environment. For Deaf students this included research relating to the use of sign languages and interpreters, and for DHH students this extended to lip reading, captioning and non-verbal communications in general.

Aristizábal, who conducted a systematic review on the use of collaborative learning for deaf students (Aristizábal *et al.*, 2017), again found a lack of research in the area. This review focussed on children and acknowledged an even greater lack of research for adult deaf education. Most research on collaboration for hearing and/or sight impaired students has focussed on children and compulsory education establishments (Sheehy, 2015). In higher education there exists a solid body of research into accessibility of online learning, and some aspects of accessible collaborative online learning as covered in previous sections, but there is little that focusses on sensory impairment specifically and on synchronous online collaboration with sensory impaired students. With the reduction of one sense the reliance on others for communication is increased so that BVI students are likely to rely more on aural communications and DHH more on visual communications. The complexity of managing communications in the context of participants where representatives of both communities exist is something that has not been explored to any great degree.

Ulisses et al in their studies relating to real-time communication for deaf and blind students did touch on this area but the core of their study was with DHH students with suggestions that this could be extended to BVI students, more as a proposal for extending studies than of one that had been explored. They looked at the use of software to allow for real time translation between sign and oral languages, and different sign languages.

> *"Deaf and blind students face communication barriers that are constantly present in their daily lives. These barriers arise naturally since the deaf community, the blind community and the rest of the students and teachers use different languages and different channels to communicate".* (Ulisses *et al.*, 2018, p. 1015)

They used software (VirtualSign avatars) to allow for the real time translation between sign and oral languages, with several distinct sign languages, making it possible to have deaf people from different countries understand each other. They saw this as helping to preserve Deaf culture but enabling real-time communication. They go on to suggest that by linking blind architecture using voice recognition and text to speech they could allow more inclusion with different communities, and bidirectional communication between several different types of communication channels. In their vision each user uses what they are most comfortable with. Whilst this is a powerful goal it is a view that is perhaps much more complex than is suggested in the paper.

Miller and Mizrahi explored how students who had hearing loss related to hearing and Deaf cultures. They report how their orientations to these cultures, as well as their “bicultural identity”, “immersion identity”, and “marginal identity”, related to social adjustment and loneliness. They suggested that hard of hearing students related more closely to hearing culture than students who were “Deaf” (Miller and Mizrahi, 2000). This suggests that there may be different barriers experienced by Deaf as apposed to Hard of Hearing students. Whilst most articles focus on Deaf students, Lang noted that “though the term ‘deaf’ is often used to mean students who have predominantly profound or severe hearing losses without the use of hearing aids, many ‘deaf’ students use hearing aids in the context of their academic studies in higher education. As a result, some of these students are functionally hard of hearing in the classroom” (Lang, 2002, p. 267). The article uses deaf to include the range of students from profoundly deaf to functionally hard of hearing and looked at how social and personal factors play a critical role in the success of deaf students. It noted that Deaf adolescents in mainstream settings prefer to relate to other deaf students. Moving on to higher education it found that Deaf students do not feel as much a part of the “university family” as do their hearing peers.

This isolation was noted by Kersting back in 1997 who noted the ‘culture shock’ experienced by deaf university students who had little or no previous experience with Deaf culture or language. They found that “feelings of isolation, loneliness, and resentment were most intense during orientation and the critical first year. Alienation from both deaf and hearing peers was experienced.”

Adjustments that are made to ‘accommodate’ DHH students online very much focus on the written words. There have been arguments as to whether these are effective with Deaf students for whom English is a second language, as well as the accuracy and efficiency of captioning services, and the timeliness and positioning of these captions. Where interpreters are used to facilitate communication there has been research both into the effectiveness of communications when translation takes place and, in common with the captioning, the timeliness and effectiveness of these services.

The use of live captioning has been the subject of a number of studies. Barriers presented by captioning related to aspects such as timeliness: if the captions are not synchronised with the spoken word then timely interactions are not possible due to the delay. Where the captions are positioned and the size, colour, and contrast of captions may also influence their effectiveness. Caption text is often consumed in conjunction with other media so this is an aspect that has to be considered as well as how important accuracy is.

The question of how accurate captions are required to be in order to be effective has been addressed in a number of studies.   In terms of consuming captions Kushalnagar et al. noted that "While hearing consumers can watch and listen simultaneously, the transformation of audio to text requires deaf viewers to watch two simultaneous visual streams: the video and the textual representation of the audio. This can be a problem when the video has a lot of text or the content is dense" (Kushalnagar, Lasecki and Bigham, 2013, p. 1). The article looked at the effect of providing captioning history, i.e. the ability to scroll back and forth through captioned text, rather than traditional captioning and/or transcripts, and discussed whether this increased users' ability to follow captions and be more engaged. Their results indicated that providing more captioning history on a screen may be beneficial, rather than reliance on a transcript or just live captions. They noted that whilst previous eye-tracking studies that tracked percentage of time on the audio transcription indicate that readers devote up to twice as much time on the video while viewing transcripts than captions, with the need to look back and re-read the word in order to interpret what they have read and views with a longer captioning history instead, this time could be reduced and a longer caption history makes it easier for viewers to integrate and reinforce their learning from multiple, complex video sources. They suggest that the implications are that "the overwhelmingly popular practice of using on-screen captions likely needs to be rethought in situations where synchronous visual and verbal information is presented, such as in online education." (Kushalnagar, Lasecki and Bigham, 2013)

The importance of accuracy has been explored in research such as that by Kafle and Huenfauth. Whilst traditionally a word error rate has been used to ascertain accuracy their research looked at predicting the understandability of imperfect captions, suggesting that metrics based on word importance and semantic difference were more effective than word error rate (Kafle and Huenerfauth, 2019).   This is perhaps particularly relevant in Higher Education where subject materials can contain terminology for which semantics and word significance is crucial.

The role of interpretation for DHH students has been covered in a number of studies. Back in 2002 Lang made suggestions as to what should be the research priorities for the new millennium in Higher Education for Deaf students. He highlighted the complexity of dependence on a third-party interpreter in communications. He suggested that one of the most salient characteristics of learning by DHH students is the reliance on a third-party to provide access to information and the lack of communication between student and teacher that this creates.

> *"In effect, there is little direct communication between teachers and deaf students. Rather information is received by the student through interpreting and/or real-time captioning during class sessions, or through tutoring and/or notes outside of class."* (Lang, 2002, p. 270)

He identified the need to evaluate the relationship of interpreting to learning by assessing recall of a short-term lecture for hearing and DHH students and found that, even with the use of highly skilled interpreters, DHH students tested immediately after the lecture achieved 84% as many correct answers compared to hearing students. He found too that students retained significantly more information when learning from an instructor who signed for himself as compared to those who learned through a third-party unskilled interpreter. This raises a number of issues: the distancing of the student from the tutor that occurs because of the intermediary interpreter, the difficulty of getting accuracy in translation via an interpreter, and the difference in focus required when communicating directly with a signing tutor and switching between interpreter and tutor.

Spradbrow and Power (2000) in an early study also documented that hard-of-hearing students report that they miss information during lectures. Juggling communications seems to be a significant barrier here. In Higher Education where the subject matter can be complex and require precision then the accuracy and effectiveness of interpreting can depend very much on the content knowledge of the interpreter, in the same way that the effectiveness of captioning can be dependent on its accuracy. They suggest that familiarity with content knowledge may lead to more appropriate sign selections and fewer misinterpretations and that there is a need for effective and regular collaboration and communication between interpreters and tutors to minimise the potential for mistranslation. With increased communication, interpreters who are aware of the barriers deaf students experience may be more able to adapt interpreting and advise teachers and students accordingly.

Other potential barriers presented to DHH students were observed by Lang (2002). They noted difficulties relating to recall and the use of notetaking. Language skills coupled with the challenge of attending to multiple visual tasks was shown to make note taking for DHH students inefficient. They also focused on the perceptions of mainstream university professors and deaf students regarding the expertise tutors should have, and how these differed suggesting perhaps a lack of communication, understanding, or awareness within institutions. The logistics of arranging appropriate support and the stigma, complexity and time and energy in arranging adjustments was also raised as problematic.

Whilst focusing on Deaf/deaf students it has also been observed that many students in this category had additional disabilities that impacted their ability to engage and recall sessions. In what was essentially a quantitative study, Richardson, who explored academic attainment across various categories of disability, noted that DHH students who had no additional disabilities were more likely to complete their courses than were nondisabled students (Richardson, 2015). He concludes that hearing loss itself has no effect on academic attainment, but that additional disabilities may have an impact on DHH students' academic performance. This study looked at one specific outcome (academic performance) in a snapshot view of declared disabilities and does not discuss possible reasons for the outcomes.

In terms of communication barriers for DHH students in general, there are a number of papers that discuss the differences between communicating in a primarily visual language (such as BSL) and primarily written and spoken language (English). Bottoni et al. (2013) explored Deaf-centred eLearning environments looking at alternative communication codes through sign language in video form and sign writing. They identify the importance of understanding the differences in communication issues for hearing impaired students. At the heart of this is understanding that many people with hearing impairments have difficulties in communicating with hearing ones and that communications for DHH people are often composed of codified combinations of gestures and expressions utilising the body as well as the hands and face. They suggest there is an intrinsic lack of understanding of the differences between these means of communication and that many people with hearing impairments often have difficulty communicating with hearing people. They emphasise that expressing thoughts and ideas through gestures and expressions is dramatically different from written or spoken languages and translating from one to the other is inevitably flawed. This makes written transcriptions and captioning of audio content a poor substitute for their preferred modes of communication.

> *"Sign languages are widely used within the deaf community and are composed of codified combinations of gestures and expressions involving the upper part of the body. This language basis allows the expression of thoughts and ideas in ways that are dramatically different from written/spoken languages related to a phonetic experience which deaf people lack."* (Bottoni *et al.*, 2013, p. 369)

There is a lack of a universally accepted written form for sign languages. Written transcription of audio content is often considered enough to support deaf users which, it is argued, shows a lack of comprehension of problems encountered by deaf people. There exists a dichotomy between an acceptance of sign language supported tuition, and the fact that many DHH students do not actually use sign language for various reasons including acquired deafness (where verbal language is already understood) and social constraints and prejudice.

Written language skills for DHH students who have been deaf since birth (or for the majority of their life) are often much harder to acquire.

> *"It has been observed that deafness as a condition hinders the acquisition of written language skills, which raises important issues with respect to interfaces for e-learning. This is a concrete deepening of the digital divide often suffered by deaf people. However the sole inclusion of sign language videos in web pages to translate textual contents is not a complete solution, since significant portions of the deaf community do not learn their national sign language and prefer to communicate through verbal language, due to social constraints and prejudice."* (Bottoni *et al.*, 2013, p. 369)

This suggests that creative ways of presenting and coordinating interactive visual materials are needed with novel support for content comprehension. They present a model-driven approach to developing user interfaces for deaf people. The research by Bottoni et al. certainly provides some insight into the complexities of engaging hearing-impaired students into collaborative work. Whilst the model provided might not have the flexibility needed to support accessibility in a broader context it provides opportunities for consideration in relation to UDL.

Skedsmo looked at the degree to which sign language communities are treated as linguistic and cultural minorities or simply disabled. He suggests that normocentric and phonocentric mentality belongs within the medical discourse, where deaf people are described, and hence taught, to see themselves as disabled, sick, abnormal, unfortunate – different from what we want them to be. He suggests that the result is an educational practice with a focus on normalising, ignoring the fact that signed languages are proven to be just as real as spoken languages (Skedsmo, 2016). It could be argued that the insistence of written solutions as reasonable adjustments are phonocentric, ignoring the culture of D/deaf students. He states:

> *"Deaf people have no problems communicating. Unlike early beliefs and contemporary prejudices, signed languages are proven just as 'real' (developed, rich, functional, and able to handle abstract issues) as spoken and written languages. … Seeing deaf signers as a linguistic minority rather than as disabled*

individuals gives one a different perspective. A linguistic minority simple speaks another language." (Skedsmo, 2016, p. 5)

Combining collaborative learning with deaf education is something largely missing from research. Returning to the systematic review conducted by Aristizábal et al they suggested that "The fact that only 11 studies were found in 5 years illustrates the lack of research regarding the implementation of Collaborative learning to support the education of deaf children, since only 6 out of the 11 studies were focussed on them." (Aristizábal *et al.*, 2017). This again focuses primarily on children, and therefore not in Higher Education.

They promote the use of collaborative learning and ICT in educational environments suggesting that this would help to promote learning both inside and outside of the classroom as well as improving communication skills with both deaf and hearing children. For this they suggest that

"skills related to communication (literacy, sign language or lip movement) are one of the main objectives for researches that work with deaf community."
(Aristizábal *et al.*, 2017, p. 7)

More recent studies explore the relationship between spoken language development and dependence on visual communications: "for individuals born with hearing loss or in whom hearing loss occurs prior to language development, the specific requirements for learning move from the auditory channel to the visual channel" (Alshawabkeh, Woolsey and Kharbat, 2021). This leads to challenges developing communications based on the spoken language (such as captioning or transcriptions).

"(sign language) which is a visual-spacial language that does not quite match the native spoken language. In all sign languages, the whole body is used, including facial expressions (facial grammar), which is required for depth of understanding. Since sign language does not match the grammar of spoken language, the acquisition of the written language becomes a challenge, which affects reading comprehension and writing". (Alshawabkeh, Woolsey and Kharbat, 2021, p. 1)

This is seen in many studies as a basis for barriers, the fact that Higher Educational institutions are not prepared for supporting DHH students, and the reliance on providing spoken language equivalents which is often considered sufficient. This highlights another barrier previously touched on, the lack of understanding or training of hearing education providers on supporting deaf students.

Other research into online teaching of DHH students covers some of the same material as outlined above including McKeown and McKeown who focused on language and communications difficulties arising from the differences between sign and spoken/written English, and the fact that language acquisition in general is more difficult for Deaf learners. They also raise the issues of accessibility efforts failing to consider "different layers of access that a student must navigate in order to fully access course content." (McKeown and McKeown, 2019, p. 506). They suggested that for deaf students barriers exist at every level of course access: the learning management system, the materials, and in communications. "The challenge for deaf students in an online learning environment has nothing to do with the things they cannot hear and has everything to do with the nature of the English language and its heavy use in online instruction." (McKeown and McKeown, 2019, p. 512). They advocate for interventions such as the use of Universal Design principles, and giving students control over how they learn and demonstrate learning.

In summary much of the research in learning and DHH relates to children and Deaf as opposed to DHH students. Online there is a focus on communication problems, the differences between sign languages and spoken/written languages and the problems raised by use of interpreters and/or captioning.

BVI

Research on inclusion for blind or visually impaired students often focusses on the materials and the production, timeliness and appropriateness of learning materials used in group work. Whilst this does enable activities such as tutorials and lectures to become much more accessible for BVI students this does not help with 'live' activities such as the use of whiteboards or practical visual activities. Making web materials accessible by following World Wide Web Consortium (W3C) guidelines is often seen as sufficient accommodation for visually impaired students but reading learning environments and content is often much more complex and in collaborative synchronous online learning there are additional complexities that need to be addressed. Research, as with DHH educational research, often focusses on children and on blind rather than visually impaired students. In terms of the basic principles of consuming web pages Rubegni et al., 2008 proposed a solution for blind users based on reading strategies i.e. a planned way of "listening to" web pages:

> *"Technical recommendations (as those of the W3C) are not sufficient to guarantee actual accessibility, that we define as the possibility for the users of "reading" the website and "navigating through it" in an effective manner. A consequence of our approach is the emphasis on design, as a way to achieve*

actual accessibility, and on usability (by blind users) as the main evaluation criterion." (Rubegni *et al.*, 2008, p. 250)

Kohlmann and Lucke, (2014) extended research beyond web pages looking at non-visual usage of virtual classrooms. They identified new barriers that arise, especially for blind users, with the increasing use of dynamic, graphical, and synchronous content and communication, especially the use of whiteboards. These problems related to needing parallel actions, their graphical content, and unclear spatial relations. They suggest the need for augmenting educational resources to allow for more interaction in learning environments. The intrinsically graphical nature of whiteboards seems to be a significant barrier for its use with BVI students. These are frequently used in online educational environments allowing the use of collaborative content creation. Whilst static material such as slides and shared word documents that might be used as resources within a synchronous online collaborative session have the potential to be optimised for accessibility when created, shared collaborative items such as interactive whiteboards where students can contribute and explore problems collaboratively still provide barriers to BVI students. Online interactive whiteboards allow pen-based interactions in a way that content drawn on the board can be captured and accessed later but consuming and contributing content is often not possible for BVI students.

Kohlmann and Lucke documented the barriers encountered when using non-visual work techniques such as inaccessible graphical content without alternative descriptions, interface elements which can be focused on but do not provide descriptions, and interface elements which cannot be focused via keyboard at all. They also recognised that an important aspect of accessibility is the possibility to configure the room according to the users' requirements. An interesting aspect of their study was the barrier presented by not having an 'overview' perspective. Students without sensory impairments are used to rapidly processing visual and aural information in order to get an overview to both direct their attention and to understand how to navigate online. As blind users first explore details to construct the whole picture, being able to obtain an overview perspective over existing content is important. In some virtual environments the content in the main presentation panel is rendered in such a way that it cannot be read. The other issues raised was that of when changes occur to the visual online, such as rearranging windows on a shared screen. Again, these might be processed with minimal effort by sighted students, but noticing changes is much harder for visually impaired ones. They emphasised how these changes "are vital for keeping track of information and seeing connections e.g. between questions posted in the chat and the corresponding elements on the whiteboard. Shared desktop, presentations and whiteboard content pose severe accessibility problems" (Kohlmann and Lucke, 2014, p. 591). Most platforms do not support the 'perception' of whiteboard actions or alternative work techniques for controlling the whiteboard, their rendering is mostly visual. Whilst alternative descriptions for graphical content can be generated using closed captions but are not completely accessible. They concluded in this study that "the analysis of non-visual usage of virtual classrooms using screen reading software shows that none of the solutions considered is fully accessible. The main barriers encountered were due to a non-accessible interface elements and presentation of content as well as a limited overview of status, events and related content." (Kohlmann and Lucke, 2014, p. 591)

Making whiteboard content accessible to screen readers is something that was considered by Freire et al. (2010) who focussed in on the challenges of using interactive whiteboards with blind students in the context of synchronous e-learning activities. They looked at how whiteboards could be used inclusively and collaboratively by using a live mediator to provide accessible textual descriptions. These allowed BVI students using screen reading software to navigate through the elements of a whiteboard during a live interactive session. The case study undertaken showed the potential for the approach to be effective and suggested this as a starting point to provide blind students with resources from which they would normally be deprived. This has parallels with the use of a live captioner or BSL interpreter and is likely to encounter the same problems. They acknowledge that the drawings, use of colour, and arrangement of the elements on a board provide very important contextual information which is essential to understanding content. The proposed mediator provides the possibility of navigation through this content with a screen reader. Whilst the case study was limited it did reveal some possibilities and the feedback from the participant was revealing. Having never had access to whiteboard content before and interaction was highly valued "it is like being able to play with something I had been deprived from my whole life". With technological advances there is some potential for this to be explored, perhaps through artificial intelligence in the same way as live captioning can be created.

Looking more generally at accessibility for BVI students, Fichten et al., (2019) conducted two studies on the accessibility of e-learning materials and other computer technologies for 143 Canadian college and university students with low vision and blindness. The first study evaluated the extent to which the student's adaptive computer technology met their educational needs, while the second study focused specifically on the types of e-learning technologies that faculty members used in their courses. The results of the studies demonstrated that blind students were impacted at significantly higher rates than their counterparts with low vision. Some of the more common issues reported by the students were the inaccessibility of the course management tools, materials like PDF documents and PowerPoint presentations, and the lack of technological support at an institutional level to resolve any e-learning challenges encountered. The inference in this is that it is the responsibility of all stakeholders in the process to ensure that the virtual educational experience is accessible to all.

In the US, Betts provided a ‘national perspective on online learning, accessibility, and student success’ in her paper reporting on a Q&A with the National Federation of the Blind (NFB) and the Association of Higher Education and Disability (AHED) exploring institutional commitment to accessibility (Betts, 2013). Speaking as a representative of the NFB in this paper, Mark Riccobono suggested that if built correctly the aspects of online learning that lend themselves to improving access and success for students are those that eliminate the perceived and real barriers in traditional educational models. He suggested that the anonymity presented by attending online offered the chance for every student to be perceived as being equal from the start as opposed to in traditional settings where misconceptions inevitably have influence. “From that initial moment (entering a room as a blind man) I am working to correct those misconceptions in order to be able to actively participate fully as an equal member of the class” (Betts, 2013, p. 107) He goes on to suggest that if the online environment is constructed correctly all students will have equal access to information. He suggests that “the most limiting aspect of online learning for many students with disabilities is the interaction between the online course management system and the student’s assistive technology” (Betts, 2013, p. 108), stating that this was particularly true for students with visual disabilities who rely on screen readers.

As with other studies the lack of understanding of the needs of disabled students by lecturing staff and course designers is raised and the fact that these needs are not met, or perhaps considered sufficiently, when developing courses. “Building accessibility into the course during the design phase is the most efficient and cost-effective way of providing access, yet we hear from many of our members that their colleagues in distance learning and educational technology choose to wait until a student makes a request. This can be too late for many of our students” (Betts, 2013, p. 108). This returns to the notion of universal design needing to be embedded within an institution to be effective. Interestingly, he suggested asynchronous communication (such as forums) could be more problematic because of the delay. He suggested that the waiting time could be challenging as many students with disabilities had not experienced an independent learning environment before and needed “good, independent learning skills and disability management skills to succeed in online courses”. He did, however, acknowledge that this inexperience might be a challenge for all new online students, disabled or not.

Returning to the importance for faculty to understand the dynamics of making things available in accessible format and how they can do that, it was suggested that instructors need to hear from students with disabilities. Their experience was that many instructors were unaware of the struggles blind students faced, especially in online courses. "Partially this is true because many students expect to face barriers and just work to get through them. Part of faculty enrichment needs to be getting to know these students, hearing about the barriers they have faced, and understanding how they [faculty] can help make a change." (Betts, 2013, p. 109)

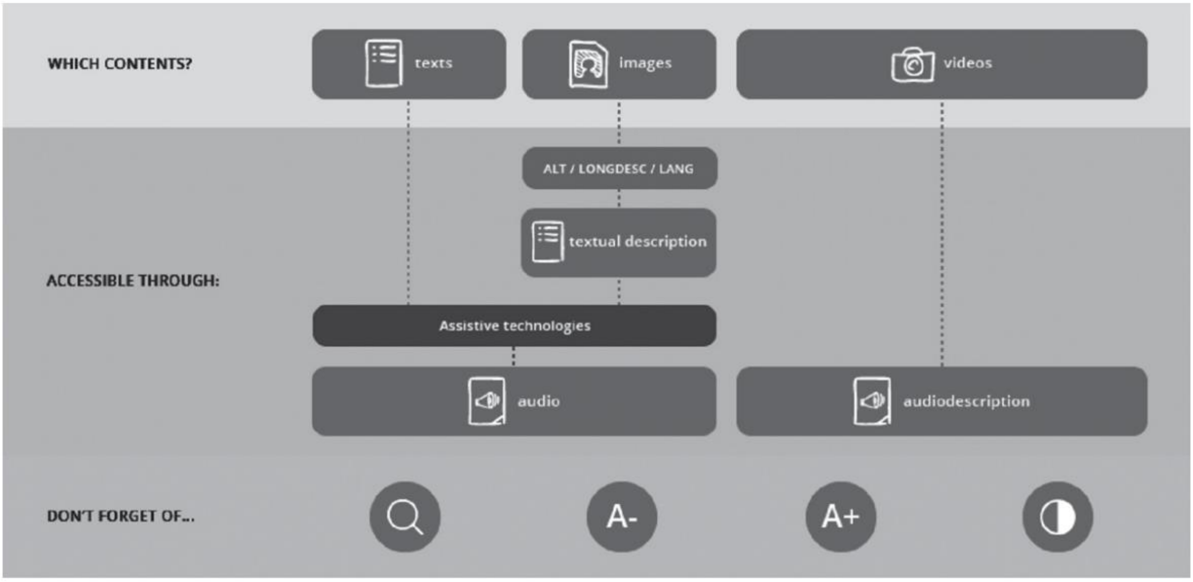
Almeida et al. (2020) also looked at the challenges and strategies for development on online digital resources. They noted that many learning environments fail to adhere to web accessibility guidelines, and that although efforts have been made to include blind users in online learning environments there is still a lack of research relating to synchronous and interactive multimedia e-learning applications.

Lisboa et al. looked at the theoretical background to the state of accessibility in Brazilian online education and attempts to identify barriers and possible tools to enhance user experience for Blind students and present a proposal for a user-experience methodology to reach that goal. They identify a gap in the research with respect to the needs of blind students in distance learning, suggesting that for students with different visual abilities the promotion of accessibility and usability must go beyond the use of the assistive technology used into the technological development stage of the educational platforms. Furthermore, they suggested researchers should be looking at new ways to enhance the multi-sensory and multimodal users' interaction suggesting that for "these users to be truly benefitted it will be necessary for the systems response to transcend the screens and reach devices that provoke tactile, auditory, and even odours and flavours sensations." (Lisboa, Barroso and Rocha, 2020)

Almeida et al. looked at the challenges and strategies for developing an online digital resource accessible for students with visual impairments (Almeida *et al.*, 2020). They highlighted the visual complexity of some courses, citing science courses as particularly complex. To explore these challenges and strategies they used a DBR approach to develop and produce a multimedia Occupational Safety and Health resource. Video content and games included in the "Hands on" section were identified as the main challenges, as they had to be perceived and playable by sighted students and by students with visual impairment or blindness so they wanted to make sure that solutions were not based on the use of alternative versions. The implemented methodological approach (DBR) was not based on the use of alternative versions for each one of these groups of students, but to develop solutions that both could access. Previous studies had already shown that high school students with visual impairment claim "doing nothing" as one of the most frequent activities at school (referencing Jessup et al., 2018), when the contents or methods are inaccessible.

It is, therefore, mandatory to create accessible resources specifically designed to those people who are unable to access the visual side of the web. They demonstrated that by considering accessibility challenges from the outset and application of an iterative analysis, design, development, implementation, and evaluation cycle they were able to address accessibility issues effectively and make the resource accessible for visually impaired users and screen readers. They used what they described as a “methodological path” to show that texts, images and videos can be made accessible using audio and audio-description features alongside alternative text, zoom, adjustable fonts and contrasts (see Figure 3 Almeida - How to make web-based content accessible to blind and low vision users).

Figure 3 Almeida - How to make web-based content accessible to blind and low vision users



Improvements and innovations in technology have impacted the effectiveness of assistive technology and therefore the accessibility of web materials. McLaughlin & Kamei-Hannan’s results indicated that the use of digital devices increases reading speed of users with low vision when compared to large print paper, allowing users to adjust the font size, style, and colour preferences (McLaughlin and Kamei-Hannan, 2018). The Beal and Rosenblum study also revealed a positive impact on the performance of students with visual impairment to solve mathematical problems using an assistive technology with a tablet instead of working with print or braille materials, depending less on the teacher and feeling more motivated. (Beal and Rosenblum, 2018).

Screen reading software tends to focus on sequential and linear rather than parallel formats so navigating a screen can be time consuming and complex (Gornitsky, 2011). This makes collaboration, particularly in a synchronous online learning environment, difficult. Adaptive software programs are often only adaptive to the specific environments for which they were designed. Blind individuals still struggle with poorly designed computer interfaces and the adaptive software often continues to lag behind in detecting online content features and reading web layout.

Bualar (2018) looked at barriers to inclusive education in Thailand and the voices of blind students. They indicated that in Thailand research involving people with disabilities is predominantly medical-framed, that very little is known about their opportunities for pursuing higher education, and that the barriers to such education have been left unexplored. The study, which focused on visually impaired students who study at universities in Bangkok, sets forth a qualitative method for investigating barriers that affect the inclusive higher education participation of blind students. Using a phenomenological approach to identify and reflect upon the students' experiences they carried out face-to-face interviews with 12 blind students. These indicated that unfriendly physical environments on campus, lecturers' inaccurate understanding of inclusive education, and inclusive higher education policy inconsistencies limited their active learning opportunities. The author recommended that senior university administrators introduce "sharply tailored interventions to adopt universal design concepts, appropriate academic adjustments, and campus-wide inclusive practices that contribute to supporting the educational achievement of blind students", and that "top university executives, academic departments, blind students, and their families must share inclusive values and establish a healthy dialogue to create a truly inclusive education" (Bualar, 2018, p. 469). They concluded that without coherent inclusive education policies from the central government and strong determination from universities, the ultimate goals of inclusive higher education would be unattainable.

Beal and Shaw (2009) looked specifically at problems of teaching maths to blind students. This research was limited to blind not visually impaired, and focused on text-to-speech solutions for making online instruction accessible to blind students through audio narration. In undertaking the study they acknowledged that there are relatively few studies of maths learning by students who are blind, and similarly few maths teachers with training in how to help students who are blind. The study raised a number of issues including problems with adapting existing programme. The study was limited in that it involved only basic maths calculations. More complex formula, or graphical subjects such as charts, geometric shapes or plots were not addressed which would potentially prove far more problematic for a text-to-speech solution. They also raised the problem of the difficulty in comparing performance with sighted students (where different tools were allowed). Whilst exploring memory constraints with longer wording on questions they ascertained that the strongest influence was difficulty of maths problem rather than the complexity or length of the wording.

Much of the research in the area of BVI online teaching focusses on production and usage of accessible, screen readable materials and resources. Although areas like use of whiteboards in synchronous online sessions and the accessibility of the learning environment technologies have been covered, a holistic approach to accessibility for BVI students' engagement in online collaborative learning has not really been explored.

2.6.5 Reasonable Adjustments

When looking specifically at inclusion for SI students it is perhaps best to reflect on current practices and an understanding of the concept of existing "reasonable adjustments". This is the term HE in the UK is required to adhere to for increased inclusion for disabled students. Disability Right UK[10] makes suggestions as to support services that students should be able to access to enable them to make the most of their studies.

Blind or visual impairments

For onsite training a mobility trainer to learn routes to place of study, accommodation, campus and surrounding area is suggested. They also suggest time to get used to the campus or site, providing a support teacher, worker, or a sighted guide, and making students aware of evacuation routes and/or drawing up Personal Emergency Evacuation Plan. When at a campus-based university this is more feasible than at an institution (such as the OU) that provide face-to-face learning events at third-party venues.

Use of a personal reader to read course material and exam questions, scribes, amanuenses or notetakers to take notes in lectures and dictate answers in exams, large print, tape, or Braille transcription services, handouts and booklists in advance for transcription, course material in Braille or in large print, audio format, or via email and exam papers in your preferred format, digital recorders for recording lectures, notes, audio description of visual props used in lectures (or alternative methods of teaching) are all suggestions for learning materials and learning events. Suggestions also cover arrangements for placements and field work, use of assistive technology, e.g. closed-circuit television, computers with speech synthesisers and magnification, Braille notetakers, and text scanners, and the use of assistive technology in exams. In physical locations considerations including private study area in the library, longer book loans and special arrangements for photocopying, an exercise area for guide dogs, good lighting, adequate signs and good colour contrasts on signs and buildings, taking exams in a separate room with an invigilator, extra time to

[10] https://www.disabilityrightsuk.org/adjustments-disabled-students-and-apprentices (Accessed: 29/09/2022 09:03)

read, understand, and produce answers in exams, and that all exam invigilators to be aware of a student's impairment so they can give time warnings and tell them when to stop writing, or provision of alternative exam arrangements where necessary.

In assignments allowing for deadline extensions on assessments as and when needed, modifying or adapting equipment to allow students to participate in practical classes e.g. handheld illuminated magnifiers, beakers with raised markings, talking thermometers.

Deaf or hearing impairments

Reasonable adjustments for DHH students include a human aid to communicate, e.g. sign language interpreter or lip-speaker and signing of exam questions, qualified support teacher or tutor, e.g. for language tuition and concept support, notetakers, remote captioning, changing the language of exam papers if you are pre-lingually deaf, an induction loop system in lecture halls and seminar rooms, radio or infrared microphone system, textphone (e.g. minicom) at home, in the Students' Union and/or somewhere easily accessible at the college, and for video materials to have subtitles.

On the staffing side they suggest that all staff receive deaf awareness training, all exam invigilators be aware of impairment so they can give time warnings and tell students when to stop writing, and for people with regular contact with DHH students to take British Sign Language (BSL) classes. A digital recorder and/or copy typist to record lectures, covering the cost of photocopying course materials, and software to help with English, particularly grammar, are additional suggestions.

In a physical learning environment, a flashing light or vibrating pad for the fire alarm (a flashing bell for hall of residence room), with a Personal Emergency Evacuation Plan to ensure you can evacuate the building safely in an emergency.

In exams suggestions include extra time to read, understand, and produce answers in exams and the use of a separate room with an invigilator.

2.7 Moving Learning Online as a Consequence of the Global Pandemic

The significant shift to online distance learning as a consequence of the COVID 9 pandemic has raised a global focus on the concerns and implications of rapidly moving learning online from traditional face-to-face.

Alshawabkeh et al (2021) study looked at the impact of moving online for a group of Deaf students during COVID-19. They suggested that colleges and universities are not typically prepared for supporting deaf students, so their specific needs are not well understood and that the lack of understanding is not for want of intent; is it is simply a lack of experience on the part of the institution. This appears to be a common perception. The move to online had highlighted a number of problems for deaf students, particularly relating to communication. Deaf students in the study who relied on sign language for learning also relied on a sign language interpreter for understanding coursework presented through online distance learning. They highlighted the importance of understanding that it is erroneous to assume that online classes are accessible to deaf students just because the interpreter is on the screen.

They also highlighted a wider issue in that “inclusion design for deaf students is often developed as a workaround, with the assumption being that deaf students are like hearing students, except that they cannot hear. That historically simplistic misunderstanding leaves postsecondary instructors with the illusion that if the content is delivered in an alternative manner, all will be well”. (Alshawabkeh, Woolsey and Kharbat, 2021, p. 2)

Problems with managing the learning environment online highlighted the complexity of communicating in a disjointed way “It is common for hearing individuals to look at the interpreter who is talking rather than the deaf person. Students advised (the author) to look at the deaf person and simply listen to the interpreter” this again brings back the distancing of the student from the teacher/tutor and their peers.

Other studies, such as that by Oleszkiewicz (2021) supported the notion of complexity of moving online suggesting that deafness is more difficult to overcome in the social context that other disabilities such as blindness.

- Using text only is not helpful for deaf students
- Students felt overwhelmed (online). Without being able to see the instructor the course content quickly appeared overwhelming and disjointed. They saw only the interpreter. The content was too heavily based on reading
- Content that is well organised and available for students prior to the class also provides opportunities for pre-reading. The interpreter should have access and be required to read the material to avoid misunderstandings
- Recommendation to keep the instructor, interpreter and students on screen or at least give the option for the student to keep any of them simultaneously on screen. This option will facilitate the communication channel between the instructor and the students and among the students themselves inside the online classroom
- It is important to recognise that deaf students are visual learners and, because of their deafness, they attend to one visual input at a time

- A student stated that, “we can’t focus on the interpreter while reading the slides. We need the instructor to give us at least 2-3 min to read a slide before we can watch the interpreter.” In a study of visual attention Thakur found significantly slower processing speeds for deaf students than among their hearing counterparts.

Alshawabkeh at al. (2021) make a number of recommendations with respect to moving to online teaching for DHH students including training for all instructors on the effects of deafness on learning, effective strategies for teaching visual learners, and on classroom needs of deaf students. Training for instructors on working with an interpreter and engaging deaf students in planning how the class will run (e.g. turn-taking, time for reading the screen, “screen breaks”).

2.8 Research Question and Gap Addressed

If collaboration is important and beneficial to learning outcomes, then it is important that the collaborative experience is open and accessible to all students and that they can engage freely in online collaborative activities whether synchronous or asynchronously. This requires, as a minimum, students to be able to communicate effectively with peers and tutors but the requirements for full participation in online synchronous learning events extends beyond purely communication needs and this is an area that has not really been explored.

Research has shown the importance of collaboration, and the accessibility of online tuition and learning has been researched. An area where it seems to be failing, and where there is limited research, is the accessibility of online synchronous collaborative activities which are often built into the learning model and curricula and may form required components of courses. Sensory impairment presents specific problems as the loss of one sense in a multi-medium environment can make it difficult to engage. Without engagement then collaborative learning is not possible. Whilst enabling engagement does not de facto lead to collaboration the removal of the barrier makes this collaboration possible so is a significant step towards it.

When teamwork and collaborative effort forms part of the assessment criteria for a unit of study then this further increases the importance of accessibility.

2.9 Research Question and Gap Addressed

Understanding what the barriers are for SI students, and potential interventions to reduce these barriers, would enable institutions to explore and implement solution to embed inclusion and accommodations into the learning environments, design, and delivery processes for these learning events.

The questions posed for this research attempt to take a holistic view on inclusion for SI students in online collaborative synchronous learning, exploring what the barriers are, how we might address them, and how we can improve inclusivity as a consequence. The research questions addressed here are:

RQ1 How can we improve inclusivity in online collaborative learning for students with sensory impairments?

RQ2 What are the barriers to engagement for students with sensory impairments?

RQ3 What interventions can we design that might improve inclusivity for sensory impaired students in online synchronous collaborative learning events?

2.10 Summary and Conclusion

This research is placed within the context of inclusion, accessibility, and collaborative learning research. Design and environments are also core components. There is a strong pedagogical case for collaborative working improving learning outcomes and developing deeper meaning. There is also a body of work that understands the complexities of online collaborative learning and the significance of the learning environment in student engagement and participation. When looking at barriers to access to online learning various components of the environment have been explored such as the quality of collaborative activities and materials, the general accessibility of learning environments, and the comparison of synchronous and asynchronous collaborative learning.

In terms of barriers to access, there is technical information and quantitative data on usage of VLEs. This data relates to location, time, duration, and achievement and is generally derived from interaction logs. Statistical analysis of this data and application of data mining models can provide some insight into collaborative patterns and participant engagement, but I would argue that quantitative data can only provide limited insight into the engagement process and richer qualitative data is really needed to understand barriers.

Existing research directly related to sensory impaired students in a synchronous online learning environment is limited and tends to focus on profoundly deaf BSL users or in the case of blind students, those with little or no vision. Studies have also tended to focus on one aspect such as the design of learning materials or shared resources, the use of interpreters or captioners, or the use of assistive technologies such as screen readers. There is an acknowledgement that there is often a lack of understanding within institutions of how best to support these students. What I would argue is that in order to implement effective inclusive learning for sensory impaired students what is missing is a holistic approach that looks at the learning environment from the perspectives of all participants and actively involves them in the research in order to identify and address the barriers that exist. This is the aim of this research.

3 Methodology

3.1 Introduction

The previous chapter, the literature review, identified the benefits and importance of collaborative learning. This, along with learning environments, and inclusion and accessibility are the source of theories underpinning this research. This research stems from, and endeavours to contribute to, this body of knowledge. This chapter explains how the methodology used in this research was selected and designed to achieve this.

The chapter is in seven sections. The first looks at ontologies and epistemology to examine the nature of knowledge and how it can be tested. It moves on to look at how the choice of a pragmatic research paradigm in 3.2 and a mixed methods approach in 3.3 meshed with the theoretical foundations and nature of the research to provide the most suitable way of addressing the research questions. A Design-Based Research (DBR) methodology was at the core of exploring these research questions, so the history and key elements of this methodology and its suitability for the research are discussed in section 3.4. Implementation of this mixed-methods DBR adoption is discussed in section 3.5 Research Design, which looks at the flow and phases of the research and how different perspectives on the research questions could be incorporated into the data collection and analysis. In the final sections the choice, sequences, and configuration of the specific methods for both data collection in 3.6 and analysis 3.7 are discussed in more detail. The chapter concludes by explaining how the adoption of this research design fulfilled the key requirements of a DBR approach and how the outputs are designed to contribute to both theory and practice.

A reminder of the research questions which are referenced throughout this chapter:

- RQ1 How can we improve inclusivity in online collaborative learning for students with sensory impairments? `
- RQ2 What are the barriers to engagement for students with sensory impairments?
- RQ3 What interventions can we design that might improve inclusivity for sensory impaired students in online synchronous collaborative learning events?

3.2 Research Paradigm

At the heart of this research is inclusive collaborative learning with aims of increased accessibility, reduction of barriers to engagement, and encouragement of sensory impaired students to actively participate in synchronous online collaborative events in the educational context. To provide a solid foundation for this research it is necessary to contextualise it in broader beliefs about knowledge, world views and ideologies. I shall begin with a discussion on the philosophical foundations (ontology, axiology and epistemology), move on to look at the theoretical stance, the methodology (systematisation) and finally the techniques (methods) used.

Crotty (1998, p.3) defined the basic elements of research process as the following:

• Epistemology: “The theory of knowledge embedded in the theoretical perspective and thereby in the methodology”.

• Theoretical Perspective: “The philosophical stance informing the methodology and thus providing a context for the process and grounding its logic and criteria”.

• Methodology: “The strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes”.

• Methods: “The techniques or procedures used to gather and analyse data related to some research question or hypothesis”

Table 1 Overview of Research Paradigms

Paradigm	Ontology	Epistemology	Question	Method
Positivist	Laws govern the teaching and learning process	Focus on valid and reliable tools to uncover these laws	What works?	Quantitative
Constructionist	Reality is created by individuals in groups	Discover the underlying meaning of events and activities	Why do you act this way?	Qualitative
Critical	Society is rife with inequalities and injustice	Helping uncover injustice and empowering citizens	How can I change this situation?	Ideological review, civil actions
Pragmatic	‘Truth’ is whatever is useful	The best method is one that solves problems	Will this intervention improve learning?	Mixed-methods, design-based

https://learn2.open.ac.uk/mod/oucontent/view.php?id=1697627&section=1.7

Ontology (the theoretical perspective) examines the nature of reality whereas epistemology examines how you can examine reality. The three common ontological stances are:

- that there is one single reality (realism)
- that there are multiple realities (relativism)
- and that reality is constantly negotiated, debated, or interpreted.

Epistemology refers to how an individual understands knowledge, how they understand their own thinking process, and how they think others know. Epistemology addresses the question "how can I know reality?" The common epistemological positionings are:

- the belief that knowledge can be measured using reliable designs and tools
- the belief that reality needs to be interpreted to discover the underlying meaning
- the belief that knowledge should be examined using whatever tools are best suited to solve the problem.

The combination of ontology and epistemology provides a holistic view on how you understand knowledge: the research paradigm (see Table 1 Overview of Research Paradigms).

Combining these three different ontologies and three epistemological positionings produces the three most common paradigms in social research, which are:

- Positivism which has the ontology that there is one single reality or truth and the epistemology that knowledge can be measured
- Constructivism which has the ontology that there are multiple realities and the epistemological stance that knowledge has to be interpreted to discover the underlying meaning
- Pragmatism which has the ontology that reality is constantly negotiated, debated or interpreted, and the epistemological stance that knowledge should be examined using whatever tools are best suited to solve the problem.

The synchronous learning environment incorporates many factors and perspectives. Barriers to collaborative participation in these environments come from complex, differing constraints, such as technical or policy issues. Arising barriers may be technical, pedagogical, environmental, communication related, and emotional. Participants in the process such as learning designers, tutors, module teams, student support staff, academics and students all come with their own perspectives, goals, skills, aims and requirements. The multitude of factors and perspectives involved requires a collective, inclusive standpoint. Identifying these barriers to engagement and finding suitable interventions is neither a simple nor a single process. In addition, there are the institutional, legal and ethical requirements of the University. Each participant in the collaborative learning process has their own reality and making meaning of the process is something that has to be constantly negotiated, debated, and interpreted. The positivist idea of a single reality seems incompatible with this collaborative experience and the underlying theoretical argument for collaborative learning discussed in the literature review section.

Taking a stance aligned with a social model of accessibility in Higher Education rather than a medical model (see Inclusion, Accessibility and Disability in the Literature Review section) is also incompatible with both the positivist and constructivist paradigms. The aim is not to look for an underlying meaning or a measured knowledge but to try to solve a specific problem: the barriers to engagement for sensory impaired students. This is driven by the research questions and needs to utilise whatever tools are best suited to address these problems and reduce them to a manageable state. Therefore, the approach used for this research is a pragmatic mixed methods approach, which takes the ontological stance that reality is constantly negotiated, debated or interpreted and the epistemological belief that knowledge should be examined using whatever tools are best suited to solving the problem. This decision has been based on the nature of the questions and evaluation of the alternatives.

3.3 Mixed Methods

The term "mixed methods" refers to an established methodology emerging from the limitations of purely quantitative or qualitative research which advances the systematic integration, or "mixing," of quantitative and qualitative data within a single investigation or sustained program of inquiry. (Creswell, 2013). The basic premise of this methodology is that such integration permits a more complete and more synergistic utilisation of data than do separate quantitative and qualitative data collection and analysis. Mixed methods can be especially useful in understanding contradictions between quantitative results and qualitative findings. They can give a voice to study participants and ensure that study findings are grounded in participants' experiences and have great flexibility, adaptable to many study designs, to elucidate more information than can be obtained in single method research. (Wisdom and Creswell, 2013). Reaching out to research participants in a multitude of ways facilitates the collection of rich, comprehensive data representing the diversity of roles. Mixed methods also mirror the way individuals naturally collect information—by integrating quantitative and qualitative data to provide a more complete story than either method would alone. (Bryman, 2016; Cohen and Manion, 2017)

There are however drawbacks in that this increases the complexity of evaluations. Studies can:

- be complex to plan and conduct
- require careful planning to describe all aspects of research
- need decisions on the weightings of quantitative and qualitative approaches
- require timings and the sequence of qualitative and quantitative portions to be determined and scheduled
- necessitate an additional plan for integrating data.

Mixed methods is an ideal technique to assess complex barriers and potential interventions to collaborative learning as it allows for evaluation of contradictory data from different studies and the triangulation of data. Mixed methods allows for an iterative approach where data can be re-evaluated at different phases of the research, hypotheses tested, and an understanding of the complexities of the data increased. As discussed in the Literature Review, the social model of disability argued that individuals were not disabled by impairments but by the disabling barriers faced in society. Following the social model of disability is the argument that universities should avoid the use of medical labels in identifying the learning needs of disabled students, and should make efforts to institute as part of everyday practice a diversity of inclusive teaching strategies. (Matthews, 2009). In order to do this effectively all stakeholders in the educational process need to participate in this practice. This research aims to identify and change practice by reducing these barriers. To do so effectively the perspectives of all stakeholders in the collaborative learning process needed to be both understood and actively involved in the research. Accessing this diversity of participants suggested a highly planned, sequential, mixed methods approach so that the barriers emerging from the data could be supported both quantitatively and qualitatively and a synergy of opinion could be extracted. To implement this a phased research design plan was developed and applied as covered in section 3.5. Fundamental to this design were the concepts of mixed methods and the implementation of a Design-Based methodology to facilitate this which is discussed in the following section.

3.4 Design-Based Research

By electing to adopt a Design-Based Research methodological approach it is necessary to explain both what this is and why it is appropriate for the research. This section looks briefly at the history of Design-Based Research (DBR), its development and application to the online learning environment, its use in existing studies, and the key frameworks for applying this methodological approach.

McKenney and Reeves defined DBR as "situated in real contexts, focusing on the design and testing of interventions, using mixed methods, involving multiple iterations, stemming from partnership between researchers and practitioners, yielding design principles, different from action research, and concerned with an impact on practice" (McKenney & Reeves, 2013). DBR is a research methodology focussing on the study of learners, their localities, and their communities. DBR embraces the complex nature of learning systems, looking at the interactions amongst variables and participants as the key components to study. The basic process of DBR involves developing solutions or interventions to problems in an iterative, collaborative way. Interventions are evaluated and tested to gather more data. Key also to the concept of the DBR methodology is that the approach should generate new theories and frameworks for conceptualising learning.

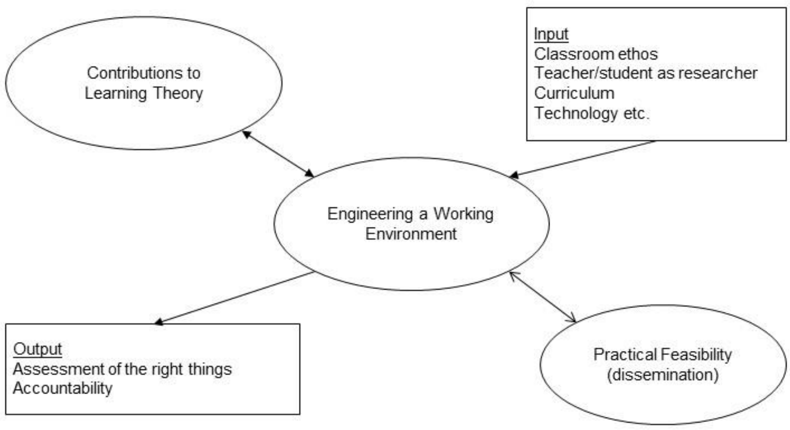
The DBR paradigm is one that advances design, research, and practice. It challenges the assumption that research is contaminated by the external influence of the researcher (Barab and Kirshner, 2001). This allows the researcher to become part of the research collective and share and exchange ideas and interventions.

3.4.1 Origins

DBR originated in the work of Ann Brown who advocated a *communities of learning* approach, where students are given the opportunity to take charge of their own learning. She described herself as a “Design Scientist… trying to engineer innovative educational environments and simultaneously conduct experimental studies of those innovations.” (Brown, 1992, p. 141). These design experiments were developed as a way to carry out formative research to test and refine educational designs based on principles derived from prior research and utilising an iterative process.

She saw the smooth working of the learning environment as central, and suggested that all aspects of this environment – the inputs and outputs – were part of a systematic whole and that change in one aspect of the system creates perturbations in others (see Figure 1 below). She also saw a critical tension between contributing to a theory of learning and contributing to practice, which she described as “intervention research designed to inform practice.”

Figure 4 Brown’s Design Experiment



The term Design-Based Research was formalised by the work of the Design-Based Collective who argue that "design-based research, which blends empirical educational research with the theory-driven design of learning environments, is an important methodology for understanding how, when, and why educational innovations work in practice." (The Design-Based Research Collective, 2003).

3.4.2 Online and Technology Enhanced Learning

Later developments in DBR have looked at it in the context of online and Technology Enhanced Learning (TEL) environments. Wang and Hannafin focused on DBR in TEL seeing DBR as a methodology that is both systematic and flexible. As with the fundamental principles of DBR, the crux of their perspective of the methodology is the use of iterative analysis, design, and implementation that is applied through collaboration between researchers and practitioners in real-world settings. They discuss how in DBR researchers "manage research processes in collaboration with participants, design and implement interventions systematically to refine and improve initial designs, and ultimately seek to advance both pragmatic and theoretical aims affecting practice." (Wang & Hannafin, 2005). They developed a framework based on nine principles which have been adopted during this research

1. Support design with research from the outset
2. Set practical goals for theory development and develop an initial plan
3. Conduct research in representative real-world settings
4. Collaborate closely with participants
5. Implement research methods systematically and purposefully
6. Analyse data immediately, continuously, and retrospectively
7. Refine designs continually
8. Document contextual influences with design principles
9. Validate the generalisability of the design

3.4.3 Why DBR fits the research

As a methodology designed by and for educators, with the aim of increasing the impact of educational research into practice DBR provides an appropriate and useful framework for this research. This research attempts to identify and design innovations for addressing the barriers to collaborative engagement for students with sensory impairments, so the principles and practice of DBR provided a good fit for the research requirements: it is theory-driven, involves stakeholder participation, contributes to Learning Theory, and requires an iterative design process.

This educational research is based in a real context (the Open University) and focusses on defining and addressing the barriers to engagement in collaborative synchronous online learning activities. The framework emerging from this research is conceptualised in a Model of Accessible Collaborative Engagement (MACE) which is intended to inform the practice of participants in these activities and has been developed using mixed methods in partnership with students and staff in an iterative process. As this research is both driven by theories of collaborative learning and learning design, and aims to find and evaluate educational innovations to improve collaborative engagement for sensory impaired students, it fits well with this argument for DBR.

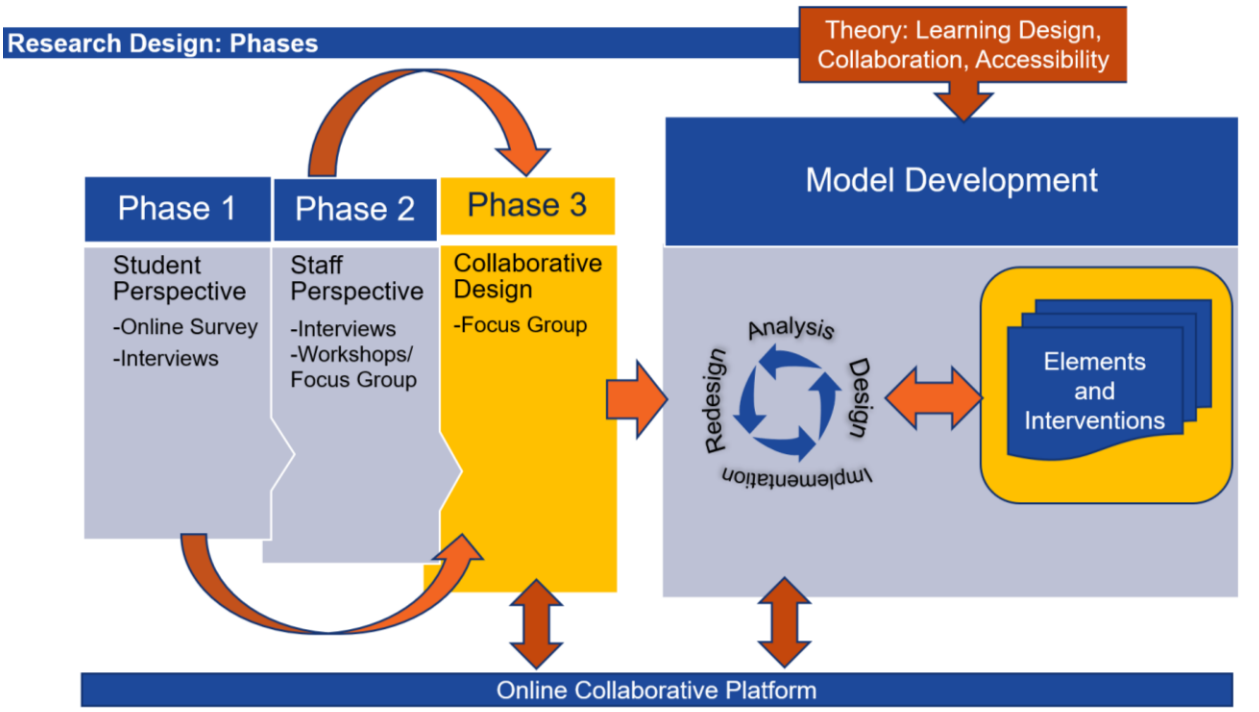
As an experienced participant in online synchronous learning activities both as a student and a tutor, and as someone with hearing loss, I wanted to test my assumptions and exchange ideas in a way that was not dictatorial or asserting undue influence on outcomes.

Principles of a DBR approach and the adoption of mixed methods informs the research design discussed in the next section. A collaborative approach had to be at the heart of this.

3.5 Research Design

In formulating a design plan for the research the key elements of DBR were incorporated. This plan was driven by learning theories relating to collaboration, learning design, and UDL (see literature review) and with the researcher in collaboration with participants, practitioners, and students. The research design is visualised below in Figure 5 and Figure 6. Figure 5 shows the phases of the research and the linkage between the component parts, and Figure 6 shows the sequence of implementation along with the outputs and data analysis methods.

Figure 5 The Studies



The studies consisted of three phases: the student perspective, the staff perspective, and the collaborative design phase. These were designed to elicit data from the two sides of the collaborative process (students and staff) and then bring them together in the final collaborative design phase to build and test the framework arising from the research.

The mapping of the research questions to phases is illustrated in Table 2 below.

Table 2 Phases and RQs

Phase	Primary Goal	Secondary Goal
1 Student Perspective	RQ2	RQ1, RQ3
2 Staff Perspective	RQ3	RQ1, RQ2
3 Collaborative Design	RQ1	RQ3

- Phases 1 and 2 aimed to get the perspectives of all stakeholders in the collaborative learning process. Students (both with and without sensory impairments), tutors, staff tutors, module team members, student support staff, academics, and student association representatives.
- Phase 3 combined participants from phases 1 and 2 into a collaborative design focus group to formalise and shape the elements and interventions required and to develop a model through an iterative process.
- An online collaborative platform, available throughout the phases, provided the tools, utilities, and links for collaboration in multiple formats (such as forums, meeting rooms, and resources). This provided both a platform to host the studies and a forum for designing and evaluating interventions.
- The model and full process was informed by existing theories on collaborative learning, learning design, and inclusion in education.

The main goal in phase 1 was to reach out to as many of the target group of students as possible to understand the barriers they were encountering in accessing, participating, and engaging in online synchronous collaborative events and to determine if online/synchronous environments were particularly problematic. Students without sensory impairments were included in the survey to provide comparison. In phase 2 the goal was to understand the current practices and resources in place to try to reduce these barriers, and the perspectives of the various staff roles associated with the provisioning of these events. In the final phase these two groups could be brought together to endeavour to address these barriers collectively. Phase 1 fed into understanding and design of phase 2, and both phases 1 and 2 fed into the formation and design plan for the focus group for phase 3. The researcher was an active participant in the collaborative design focus group which developed and produced the model as an output from the sessions. The choice of methods and the implementation of individual studies within each phase are discussed in more detail in the methods section to follow.

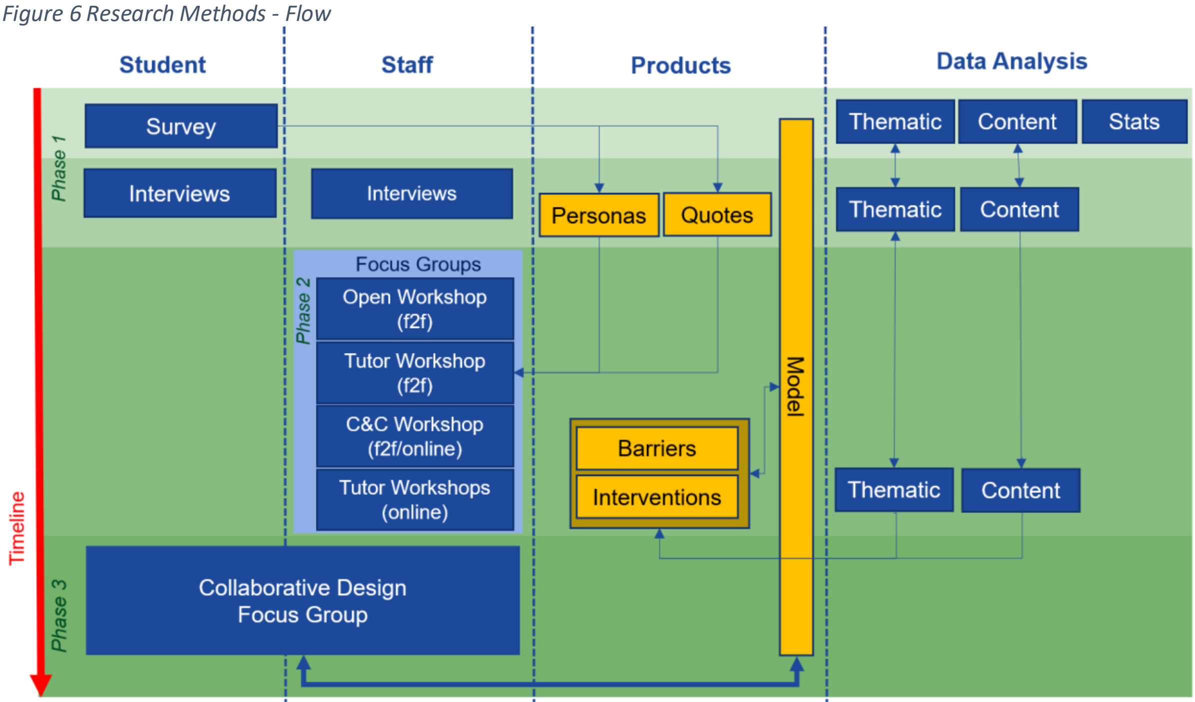
3.5.1 Sequence and Timings

Figure 6 places the individual studies in chronological sequence and illustrates how the phases contributed to and built upon the knowledge acquired from previous studies. Phases and studies within each phase are illustrated below (Table 3). There was some overlap in implementing studies 2, 3 and 4 for logistical reasons and due to the quantity of events, but studies 1 and 5 were discrete. The thematic and content analysis iterations were performed when data collection was complete for the survey, at the end of the interview phases and on completion of study 4 with each study utilising the data at that point.

Table 3 Phases and Studies

Phase	Study	Method	Participants
1	1	Online Survey	Students
1	2	Interviews	Students
2	3	Interviews	Staff
2	4	Focus Group (Workshop Format)	Open - All Staff
3	5	Focus Group (Collaborative Design)	Staff and Students

Figure 6 Research Methods - Flow



Phase 1 started with a study in the form of a survey reaching out to a wide student population. This data was analysed statistically as well as through thematic and content analysis. This led to the first phase barrier identification, and production of representational student personas and quotations derived from the survey data.

Interviews with both students (phase 1) and staff (phase 2) took place in parallel following the completion of the survey. The second iteration of thematic and content analysis took place after the interview studies.

A series of focus group workshops took place in phase 2 (study 4). These endeavoured to involve different groups of staff, both online and face-to-face and utilised the personas and quotes produced during phase 1 as triggers for discussion. The third iteration of thematic and content analysis took place after these workshops.

A product of the thematic and content analysis was the identified barriers and interventions which formed the basis for the initial model design that initiated the collaborative design focus group of phase 3 study 5.

The core design object throughout was the model, the final version of which became the product of this research the Model of Accessible Collaborative Engagement (MACE). This was iteratively developed through a process of:

- identification and clarification of barriers to engagement
- outlining and designing interventions
- adding the components to the model
- evaluating and re-evaluating the model

The choice of individual methods for each phase and studies is covered in the following sections.

3.6 Methods

3.6.1 Introduction

Data collection and data analysis methods utilised are outlined in this section including selection processes.

3.6.2 Survey Design Structure

Initial assumptions were that synchronous activities such as tutorials or module related online group work were particularly problematic because of the immediacy of response required, the limited methods of communication, and the invisibility of the disability to their peers which often necessitated declaration of disability and explanations of adjustments required to all participants. Online collaborative work seemed to add an additional layer of complexity to that of face-to-face. Therefore, the survey was designed with sections on synchronous and asynchronous collaboration and online/face-to-face collaborative formats to enable comparison, and to assess the validity of these assumptions (see Table 4 Survey Sections).

Table 4 Survey Sections

Section	Description	Type
2	Online Tutorials	Synchronous
3	Face-to-Face Tutorials	Synchronous
4	Forums	Asynchronous
4	Wikis	Asynchronous
5	Group Work	Synchronous and Asynchronous

3.6.3 Survey

The online survey was the first study to be implemented. The primary purpose for this study was to gain an understanding of the student experience of collaborative work whether synchronous or asynchronous, online or face-to-face. The research objective of this study was to clarify accessibility issues and begin to identify the barriers to engagement addressing RQ2. In addition, it was hoped to gain insight into examples of good practice and positive experiences which could contribute to RQ3.

As Cohen and Manion suggest "Typically, surveys gather data at a particular point in time with the intention of describing the nature of existing conditions or identifying standards against which existing conditions can be compared, or determining the relationships between specific events." (Cohen and Manion, 2017). Understanding the current perceptions, participation in, and experiences of collaborative learning seemed a sensible starting place.

A survey was selected as the appropriate method for the following reasons:

- A wide target student population could be accessed
- As the study was being conducted in conjunction with the Open University student demographics could be obtained to ensure a significant proportion of target students had declared sensory impairments
- Including students with and without declared sensory impairments enabled comparison between the groups to support the premise that barriers were increased for sensory impaired students

- This allowed testing of hypothesis about the target population
- Standardised information could be gathered
- Descriptive, inferential, and explanatory information could be provided
- Key factors and variables could be used to derive frequencies

This survey gathered data during the Autumn term of 2019, describing experiences and conditions relating to collaborative educational activities including tutorials and group work.

The survey was designed and processed in line with the guidelines provided by Cohen and Manion (Cohen and Manion, 2017, p. 379), and in consultation with the accessibility team at the University. The format of the questionnaire was an online survey, hosted on the learning platform. Whilst not the primary intent, this also allowed participants to become aware of, and engage with, the learning platform if they chose to do so. The advantage of this approach was that it allowed data to be collected remotely and was accessible to any registered students across all faculties and geographical areas. In order to minimise accessibility issues students could request alternative methods and formats for completing the questionnaire.

The questionnaire was presented in the following four main sections:

- online tutorials
- face-to-face tutorials
- forums and wikis
- working with other students

Each section consisted of closed questions relating to participation (dichotomous) and experiences (rating scales) followed by open questions for additional comments allowing students to explain and qualify their responses.

In addition, there was a section 'about you' in which they were asked closed questions about levels of hearing/sight, modes of communication, and use of assistive technology, again followed with open questions for additional comments. If the students preferred to provide their own definition of hearing and/or sight level this was an option. Finally, there were general questions (any other comments, option for further involvement). No questions (other than consent) were compulsory. The OU Disabled Student's Group (DSG) allowed the questionnaire to be trialled via their Facebook group.

Following ethical approval from the University's Human Resources Ethic Committee (HREC) a sample of students was provided by the Student Research Project Panel (SRPP). This sample was determined by the University in line with their selection processes, but specific requests were made for cross-faculty candidates and students with declared sensory impairments. The sample data the therefore had significant numbers of students with hearing loss and/or visual impairment. SRPP provided data included demographical information such as age, ethnicity, gender and declared disabilities. There was also information on current and previous study including faculty and module history. As the students logged into the University system to participate in the survey, student identifiers were captured, and this allowed survey data to be merged with SRPP data before anonymisation. Emails inviting participation in the research were sent to the provided sample of students. 1,065 students were approached, and 327 survey responses received. Of the students approached 551 had declared hearing impairments, 394 had declared visual impairments, 19 had declared both hearing and visual impairments (dual sensory impairment), and 139 had no declared sensory impairment to provide a comparative sample. The full self-completion questionnaire used in the survey is provided in appendix (a). It was not compulsory to answer any specific question to submit the survey (other than consent).

This survey established the different experiences of students with and without sensory impairments and began, through the first phase thematic and content analysis of the data, to identify the barriers to engagement which would be reviewed and refined through the subsequent phases of the research (see appendix a).

3.6.4 Interviews

Whilst the survey enabled a more distant approach to a large group of students, interviews enabled additional stakeholders to provide personalised perspectives and information and to involve them directly as active participants in the research. Themes arising from the survey could be explored in greater depth and evidence, data and information gathered. These interviews were semi-structured.

Interviews were chosen for the following reasons:

- to understand, evaluate and assess different stakeholder perspectives
- to test and/or develop the hypotheses arising from the survey analysis
- to gather richer qualitative data, examples of good and bad practice and reflections on experiences
- to gain respondent's opinions

- to gain specific insight into areas of interest including assistive technology use, lip reading and communication problems.

These were driven by RQ1 and RQ2.

Identification of suitable candidates was determined by analysis of the survey data to identify:

- Two DHH students with different levels of hearing loss to include a lip reader, and student with BSL as their primary language
- Two BVI students with different levels of sight, to include a screen reader user.
- A student with dual sensory impairment.

From the candidates identified by these characteristics their surveys were reviewed in order to detect candidates whose responses suggested further exploration might provide additional insights.

3.6.5 Focus groups

Focus groups were used in two different studies in this research.

- Phase 2 Study 2 - Staff workshops (6 workshops with different attendees/stakeholder groups)
- Phase 3 Study 5 - Collaborative Design group (A series of synchronous sessions with a single focus group, supported by asynchronous activities and resource materials)

A focus group is defined by Bryman as “a form of group in which there are several participants (in addition to the moderator/facilitator); there is an emphasis on a particular fairly tightly defined topic and the accent is upon interaction within the group and the joint construction of meaning.”(Bryman, 2016, p. 501). This fits with the ethos of this research of involving all stakeholders and listening to the disabled student voice.

In line with DBR ethos the researcher and facilitators were considered part of the collaborative design focus group and the design process.

Focus groups were chosen for the following reasons:

- The technique allows the researcher to develop an understanding of why people feel the way they do, allowing people to probe each other’s reasoning
- Participants are able to bring to the fore issues in relation to a topic that they deem to be important and/or significant
- A certain amount of control is relinquished to the participants rather than an interviewer or moderator allowing discussions to be participant led.

- It allows challenging and arguing over issues which are less likely in a one-to-one interview situation
- It allows the researcher to study the ways in which participants collectively make sense and interpretations of the issues.

The purpose of the first focus group sessions, the workshops, was to gain staff perspectives and responses to the barriers arising from the analysis of the survey and interviews.

Staff Workshops

Several staff workshops were run utilising personas and scenarios arising from the survey and interviews which enabled discussion amongst staff of how the barriers arising could be addressed, and the dissemination of good practice. These workshops were incorporated into the iterative design process so that the scenarios and personas were adapted in response to feedback, and the interventions arising from previous workshops were shared and discussed. Data was collected on responses to the artefacts (personas, videos, and quotes) and recordings of the online sessions were made.

These sessions were run as face-to-face, online, and combined sessions with face-to-face attendees on site and additional attendees online. Sessions were held both within and across faculties to determine whether there are different approaches within faculties and schools, and whether there are faculty specific activities or subjects which were more likely to raise problems (such as field work and experiments). This was done to replicate the different ways in which collaborative learning takes place within the University so that the modes and means of communication could inform the discussion. Sessions were conducted with mixed combinations of stakeholders (academics, support staff, learning design team, researchers), and included a specific faculty/school event and tutor only sessions.

This method supports the principles for DBR in TEL suggested by Wang and Hannafin's framework, particularly conducting research in representative real-world settings, and refining designs continually. It also aligns with the approach utilising the collaborative experience and representing the voices of all stakeholders.

Model Evaluation Group – DBR Focus Group

The final phase of the research involved a focus group comprised of stakeholders with sensory impairment. This included students, tutors, and student support staff. This focus group was driven by RQ1: *How can we improve inclusivity in online collaborative learning for students with sensory* *impairments?* And RQ3 *What interventions can we design that might improve inclusivity for sensory impaired students in online synchronous collaborative learning events?*

This allowed the target student population to have an active role in the production of the model which could be developed in an iterative process during and between the focus group sessions.

3.7 Data Evaluation Methods

The main methods used to analyse the qualitative data from the interviews, workshops and focus groups were thematic and content analysis. Statistical analysis was performed on the quantitative survey data to support the themes and assumptions arising from the qualitative analysis. The sequence of events is illustrated below.

Coding – the ascription of a category label to a piece of data - was implemented iteratively (in line with the DBR approach) and both inductively (with pre-defined codes from previous study evaluations) and deductively (with codes emerging from the data). "Codes may be decided in advance, ex ante, pre-ordinate from theory and/or from the research question or, to be faithful to the data, they may be responsive and emerge from the data." (Cohen and Manion, 2017, p. 669).

3.7.1 Thematic Analysis

Thematic analysis was deemed appropriate here in that, as Braun and Clarke argue, "thematic analysis is a qualitative research method that can be widely used across a range of epistemologies and research questions. It is a method for identifying, analysing, organizing, describing, and reporting themes found within a data set." (Braun and Clarke, 2006). By using this iterative process, repeating the coding process at each stage both deductively to identify new barriers, and inductively to confirm the consistency of the thematic results, a confidence in the themes and elements identified could be established.

The coded data was then analysed in line with Braun and Clarke's six phase guide to performing thematic analysis, a "vocabulary and 'recipe' for people to undertake thematic analysis in a way that is theoretically and methodologically sound" which has been widely adopted. (Braun and Clarke, 2006, 2019). These steps are outlined in the appendix. Steps 3 to 6 were performed at the end of each new study contributing to the iterative development of the model. This process was chosen as a means to address research question 2 (the identification of the barriers), which emerged as the four sectors and individual elements of the final model.

3.7.2 Content Analysis

Content analysis on the coded responses to the qualitative data was performed at the end of P1S1 (the survey). This was reassessed at the end of phases two and three to highlight any changes or discrepancies.

Each of the themes identified in the thematic analysis phase was analysed in terms of the number of coded responses. This was then further calculated to identify the number of distinct respondents for each theme and the number from each SI group (BVI, DHH, both BVI and DHH, and the comparison group). This provided a robustness to the findings ensuring that themes arose from the target groups and from different respondents.

At the end of phases 2 and 3 the content analysis was revisited after clarification and re-definition of the themes as a consequence of the additional data collected.

3.7.3 Data preparation

The survey responses were merged with the SRPP data provided to produce the complete dataset for analysis as shown in appendix (b).

Anonymisation

Once survey responses had been matched with SRPP data any personal data was removed so that the data was anonymised. This process was done in line with the guidelines provided by the Information Commissioner's Office. Personal data means any information relating to an identifiable person who can be directly or indirectly identified.

> *"This definition provides for a wide range of personal identifiers to constitute personal data, including name, identification number, location data or online identifier, reflecting changes in technology and the way organisations collect information about people." (ICO accessed 08/07/21)*

The University's Personal Identifier (PI) and Computer User (OUCU) numbers were removed along with names, contact details and addresses. Once the data had been anonymised, cleaned, and validated the original SRPP data and survey responses were then permanently removed from the secure OU storage site.

Pilot Data

The questions from the pilot survey were not significantly changed for the main survey so the 9 responses from this were included in the data. For these records the survey data was included as the content provided useful information, but some demographical data is missing as the respondents did not have associated SRPP data.

Derived Data

Additional fields (listed as 'Derived Data') were calculated to enable analysis of the results with respect to sensory impairment and grouping of the Likert scales. The ID field is a unique identifier for each row and is employed as a reference field for the analysis in this section.

The data is in three groups:

- Survey Data
- SRPP Data
- Derived Data

The purpose and methods of calculating the derived data are included.

3.7.4 Quantitative and Statistical Analysis

Descriptive statistics were produced from the survey data in order to understand the demographics of the respondents and to aid in classification of the responses into SI groups.

Following phases 2 and 3 further statistical analysis was undertaken on the responses to the questions in the survey, focussing on the dichotic and scaled responses to the Likert scale questions in each section.

Denscombe (2014) suggests that mixed methods research can increase the accuracy of data and reliability through triangulation and enable compensation between strengths and weaknesses of research strategies. The phased and multiple studies mixed methods approach of this research provided means to use triangulation to both enhance and extend the findings. Statistical analysis of the quantitative data allowed evaluation of a number of aspects including assessing how representative of the student population the participants were, how BVI and DHH students compared with sighted and hearing ones, and whether or not the quantitative data supported the outcomes of the other data analysis methods (content and thematic analysis).

Comparison of DHH and BVI

Two approaches were used to perform statistical tests. These were:

1. to compare students categorised as either DHH or Hearing, and BVI or Sighted.
2. To compare students across four categories: DHH Only, BVI Only, Dual SI and No SI.

The purpose of the first comparisons were to see if students with hearing loss had significantly different responses to those without, and similarly to see if those with visual impairment had significantly different responses to those without. Because of the disproportionate proportion of students with sensory impairments within the dataset this meant that those participants categorised as 'Hearing' would contain a disproportionate number of students with visual impairment, and similarly those categorised as 'Sighted' would contain a disproportionate number of students with hearing loss. For this reason, the four categories in approach 2 were created so that comparisons could be made across all variations: DHH Only/BVI Only, DHH Only/Dual SI, DHH Only/No SI, BVI Only/Dual SI, BVI Only/No SI, and Dual SI/No SI.

Choice of Statistical Tests

With the nature of the survey data collected there were a few possible approaches to take. The use of Likert scales and dichotomous questions in the survey in combination with demographical SRPP data provides scope for statistical analysis of the findings.

The statistical analysis took place at two stages of the research. After the first phase of the research (P1S1) some descriptive statistics were applied to the survey data to describe the characteristics of the sample, to check the variables for any violation of the assumptions underlying the statistical techniques used to address the research questions, and to address those research questions (Pallant, 2020). At the end of P2S4 the survey data was revisited to apply non-parametric testing and explore whether the hypotheses arising from the thematic and content processes were supported by the quantitative analysis.

Choice of statistical test was determined as outlined below. The nature of the data meant that none were ideal as will be discussed, but when combined and triangulated with the qualitative data it is possible to get a view that is consistent across the different studies of what the data is saying.

T-tests were used to consider whether it is reasonable to assume that two groups have the same (population) mean, and if there is any significant difference between the groups. These were used to assess whether Hearing and DHH groups have comparable responses to the questions, and similarly Sighted and BVI.

One-way ANOVA tests were used to see if there was any significant variance between the four categories (DHH Only, BVI Only, Dual SI, and No SI). This allowed each Likert question to act as a dependent continuous variable to allow a between groups (category) comparison. Where the ANOVA identified a significant difference then multiple comparisons could be produced to establish where the differences among the groups occur.

The limitations with this statistical approach relate to the fact that we are dealing with Likert data. In particular, this means that we are implicitly assuming that the differences between the levels of response are the same. Parametric tests, such as the 2-sample t-test, assume a normal, continuous distribution. However, with a sufficient sample size, t-tests are robust to departures from normality. For example, we are assuming that the difference between "strongly disagree" and "disagree" is the same as the difference between "disagree" and "neither agree nor disagree", and that between "neither agree nor disagree" and "agree" (Wilhelm, 2016).

With the dichotomous questions it is feasible to use the Chi-squared test for independence. This is a hypothesis test which can be used to determine whether two categorical or nominal variables are likely to be related.

It is possible to reduce the Likert scale to just two categories – "strongly disagree or disagree" and "strongly agree or agree". This was trialled with the derived fields in SPSS. The differences in proportions could then be calculated. Here the main disadvantage is that information is lost by combining categories, and this proved to be the case when this was trialled in SPSS so the full categories were maintained for the findings section. With all of these tests there is a need to be careful about multiple testing. Using $p < 0.05$ for statistical significance it may still be the case that some of these tests will come up with a significant result even if in reality there are no differences between the two groups. More importantly this can impact on tests on subgroups which might have been selected because they look the most interesting.

4 Ethics

This chapter provides a discussion of the ethical considerations encompassed in this research project, the protocols observed, the holistic approach, and issues arising. The complexities of managing online research with students with sensory impairments and the decisions and ethical considerations at each stage of the research are explored.

Ethical considerations were regarded with paramount importance and informed, determined, and directed the research from the outset. The four basic principles of ethics - justice, beneficence, non-maleficence, and autonomy[11] – apply to working with people, and in considering disabilities sensitive subjects may be broached and discussed which require consideration as to how to approach and handle them as well as considering any possible ethical situations or questions arising from the studies and how to mitigate risks. In terms of non-maleficence, the importance is that the research does no harm. This means planning on how to support people who may be affected by their participation in the research, being able to support or direct them to appropriate support. It also means making sure that the research asks questions that we need rather than want to know, and being aware of the impact these questions may have on participants. There is a need to ensure that the same people are not continually questioned, and that their expectations of the benefits of the research are managed and handled appropriately. There must be informed consent throughout, and protection of privacy and confidentiality. How these ethical policies were implemented is discussed with respect to the different studies.

OU students are often part-time and are balancing their study with other life and work commitments, so it was important that the demands placed on them in participating in the research were minimalised and that the timings of the studies was compatible with their study programme. Although collaborative activities at the OU are for the most part not compulsory, when they are an assessed part of a module they can evoke significant emotional responses such as stress and anxiety, especially around disability adjustments and self-declaration, so it was important not to exacerbate these emotions.

In researching students with disabilities it is essential that they are actively involved and have a voice in the research so that we can benefit from their expertise. It was also important that the associations representing those students at the OU, the Open University Students' Association (OUSA), and specifically the OUSA Disabled Students' Group (DSG), should support and be informed

[11] https://www.futurelearn.com/info/courses/global-disability-research-and-evidence/0/steps/99287 (Accessed: 29/09/2022 09:22)

of the research. The research was discussed with the DSG prior to the studies and with their support the survey was trialled via the DSG Facebook group.

4.1 Protocols

Planning and implementing the research included consideration of the benefits, risks and harms to all persons connected with and affected by research, as well as the broader responsibilities of researchers to the public and society. In line with the general OU researcher guidelines the aim was to maximise benefit and minimise harm, respect the privacy, autonomy, diversity, values, and dignity of individuals, groups and communities, act with integrity throughout, employing the most appropriate methods for the research purpose, have regard to their social and professional responsibilities in conducting and disseminating their research, and engage fully with the Open University opportunities for research ethics review, guidance, and training

As the research involved human participants all of whom were either active students or members of staff (in some cases both) at the OU during their participation in the research, the OU protocols for obtaining permission for this research were followed. This involved two related protocols, applications to the Human Research Ethical Committee (HREC) and the Student Research Projects Panel (SRPP).

HREC provides "a mechanism for assuring the ethical integrity of research carried out by OU academic staff and directly registered postgraduate research students." As is normal within academic institutions, an ethics review by HREC is required by the OU for research projects which involve the collection of data from human participants, and in this research project individual applications were necessary for each different phase of the research. This included the application forms outlining the reasons for the research, and supplementary materials including consent forms, participation information sheets, invitation emails and a project information document (see appendices (c), (d), (e) and (f).

Any research which involves contacting students at the Open University needs to be approved by SRPP, who on approval will provide a sample of student data. When contacting students for research purposes there are restrictions in place determining who can and cannot be contacted. The general rulings applying to sampling students implements ethical protocols and institutional policies. These include that students: have not declined to take part in research activities, have not taken part in four pieces of research approved by SRPP in the previous 12 months, have not been asked to take part in research within the past month, that research does not fall one month before an examination or final assessment period, and that the sample request and size is appropriate, taking into account the methodology and the cohort size. As a request was made for the sample provided to include a significant proportion of students with declared hearing and/or sight disabilities this further restricted the possible participants.

For each research instrument involving human participants (survey, interview, and focus groups) a separate application to HREC was required.

For each phase when invitations were sent to potential participants to take part in the study a number of supporting documents were produced and provided including clear descriptions of the aims and purposes of the study, what would be required of the participants, what the information would be used for, consent forms, and who to contact to answer any questions and/or queries.

Freely given informed consent entails giving sufficient and appropriate information about the research, to allow participants to make a meaningful choice about whether or not to take part, and ensuring that there is no explicit or implicit coercion, so prospective participants can make an informed and free decision on their possible involvement.

The HREC and SRPP procedure and protocols were adhered to, and the relevant documentation is included in appendices (c), (d), (e) and (f).

4.2 Data Collection Methods

As methods of data collection varied between studies the choice of recording data raised different ethical considerations. With DHH students communications are both verbal and non-verbal so it was essential to record video as well as audio communications (facial expressions, gestures and body language) as part of the communication data.

Data collected during the studies was stored on Open University managed resources. The core repositories for data were the Moodle[12] site, the Microsoft Teams groups (one with general access for OU staff and students, and a restricted channel for the Focus Group), and the researchers OU OneDrive. The management of data for each study is described independently.

Forums were set up so that participation could take place in a wider OU arena (accessed by any user with an OU login, in closed groups (just the participants of the focus group and the research team), and anonymously.

Once a study was complete the data was anonymised and any personal data removed from all systems to maintain participants anonymity and privacy. All data prior to anonymisation was stored on secure OU systems with restricted access to the research group. Consent forms were completed

[12] Moodle is a learning management system which forms the basis for OU modules sites

for all participants in the research and information sheets were produced in different formats to explain the purpose of the research. Students were offered forms in alternative formats if required and consent was possible through written, oral, or sign language. It was made clear in all communication that participation was voluntary and withdrawal was possible at any time during the data gathering process and up to the anonymisation of the data.

The Moodle that had been set up to support the studies included these information sheets, additional resources, options to report concerns, and links to support groups.

4.3 Individual Studies – Specific Considerations.

4.3.1 P1S1 – Survey

After following the institution protocols SRPP provided 2,000 student records. These were analysed statistically prior to the survey to get a demographic profile of the sample group. Whilst most person identifying data (such as names and contact details) were removed the student Open University Computer User (OUCU) identifier was maintained temporarily in order to cross reference respondents from the survey with SRPP data. Once the survey had closed the SRPP data and survey respondent data was combined and anonymised, dropping the OUCU which was replaced by a system generated Respondent ID. The SRPP data was then permanently removed from the secure drive as was the original survey data. It is potentially possible to identify a student based on the combination of qualitative and quantitative response to the survey coupled with module and demographic information, so the data was re-reviewed post anonymisation for potentially student identifiable content and none was found.

4.3.2 P2S2 – Student Interviews

Prior to interview students were provided with an information sheet and consent form explaining the purpose and use of the interview data. The consent forms were returned prior to interview but the information sheet and consent form were re-visited at the beginning of each interview to give students the opportunity to ask any questions and reconfirm their consent.

Student interviewees were asked their preference for the format of the interview and how they would like to communicate. The options were to some extent determined by General Data Protection Regulations (GDPR) policy at the OU which required that student video communications should take place via Adobe Connect where possible, or by telephone. Some interviews were possible face-to-face (pre-pandemic). Choice of communication method (voice/text) was made by the student. Audio and video recordings were permanently removed after transcription and viewing/analysis for non-verbal communications.

4.3.3 P2S4 – Workshops

As data from the survey and interviews was used as resources in the format of personas and quotes in the workshops the importance of anonymising these shared materials was paramount. Personas were derived from multiple participants, and characteristics cross-referenced, in order to mitigate the small risk of a student being potentially identifiable from the persona.

4.3.4 P3S5 – Collaborative Design Focus Group

It was important for the focus group to feel secure in the working environment and able to share their thoughts and suggestions freely. As with all the studies, participants were free to withdraw at any time from the process.

The focus group utilised multiple resources for communication and sharing of information, so it was important to consider privacy, access, and anonymisation factors. As all participants had access and logins to the OU systems it seemed appropriate to utilise these accounts for setting up the communication channels. A secure Teams Channel was set up for the focus group with restricted membership, as was an area of the Moodle site. Membership was limited to focus group members and PhD supervisory staff. All recordings, meetings, communications, and shared documentation was only accessible by members and membership was controlled by the researcher. Recordings, including Microsoft Teams live captioning of participants, were generated for the focus group. As analysis of non-verbal communications was required all sessions were video and audio recorded with auto-captioning. Recordings were available to all focus group participants whilst the group remained active. The motivation for this was to allow analysis of non-verbal communications, to identify errors in captioning and potential implications, and to allow participants access to the recordings throughout the duration of the focus group in order to reflect, review, and contribute asynchronously after the session. Post-session transcripts for captioning were edited where necessary to correct observed captioning errors, so recordings were presented with edited captioning. Participants were asked to flag any potential problems or errors too as this was based on the researchers processing of the communication and it was acknowledged that there may be occurrences where audio communication have been misinterpreted. Consideration of the accuracy and usefulness of transcripts was a discussion point for the focus group so this process helped to mitigate any potential influence or bias on the part of the researcher.

This was part of the iterative design process in order to evaluate the significance of some of the nuances of the barriers (such as inaccurate captioning, and the need for recordings to consolidate understanding/interpretation). This could have potentially caused problems had a participant elected to withdraw their contribution during the process which would have entailed removing the recordings and their contributions from any of the shared resources. Provisions were put in place to implement this but were not required.

As with the institution wide forums an identity protected forum was created for the focus group which would allow participants to leave comments and feedback should they wish to do so where individuals' names would not be displayed. This was not used by participants but was created in order to provide the option to remain anonymous with contributions within the group.

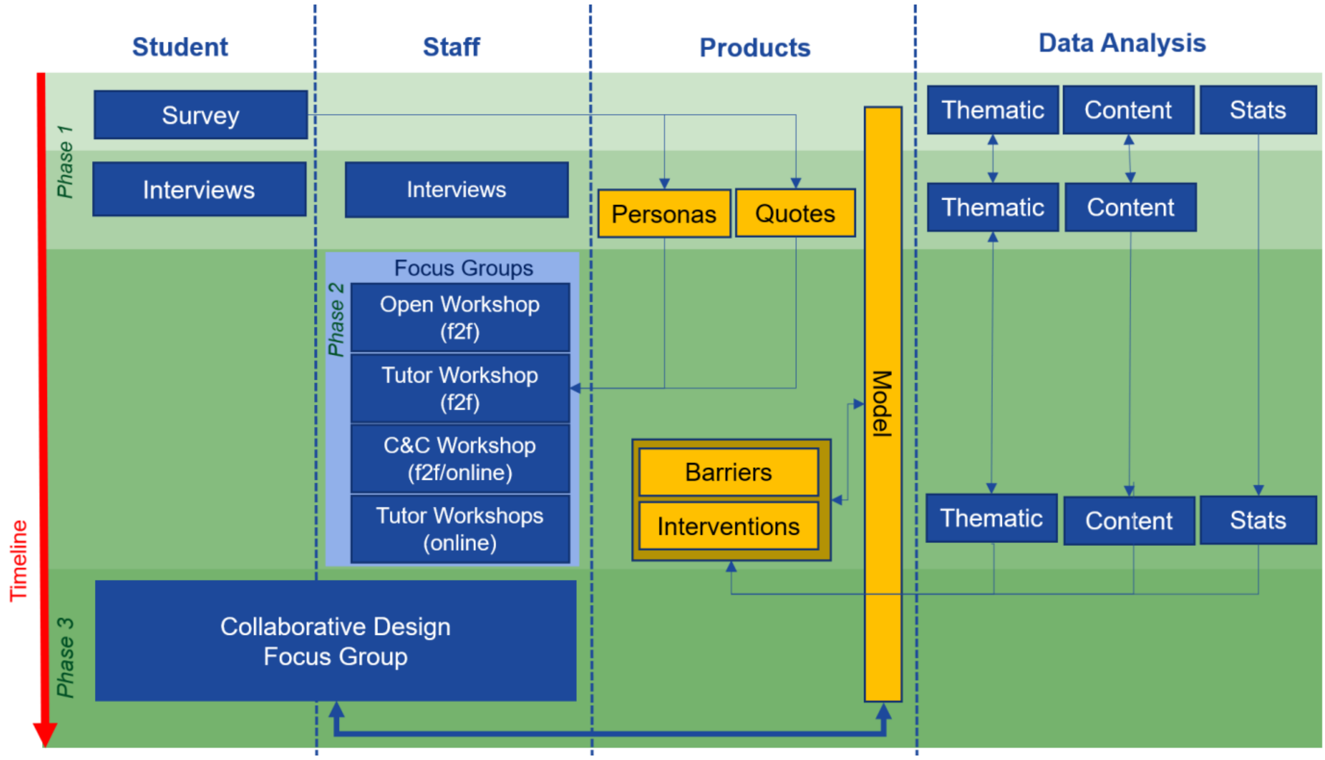
On completion of data analysis all forums, and the secure Teams channel, have been removed.

5 Findings

Chapter 3, *Methodology*, explained the adoption of a Design-Based Research methodology and the use of mixed methods in this research. The studies and sequential research design plan (reproduced below in Figure 7 for reference) indicated how these studies would be analysed. This chapter is organised in sections in line with the research design timeline and discusses the findings at each stage, how they answer the research questions, and their contribution to the design of the Model of Accessible Collaborative Engagement (MACE) framework which is a product of this research. The MACE framework is provided in full in chapter 6.

These findings are then retrospectively critically evaluated and assessed in chapter 7, the Discussion chapter, where the findings are reflected on and presented by perspective (student, staff) and the product (model). This enables the research to be evaluated both from an iterative accumulative perspective of the data, and a stakeholder/product perspective.

Figure 7 Research Methods - Flow



5.1 Overview of Data Analysis

Data analysis took place in an iterative process with each study producing new data which was then added to the existing body of data and re-analysed. Themes and codes were added to at each stage, therefore the findings in this chapter are organised and discussed from the initial theories emerging through first stage data analysis and through subsequent iterations at each of the key sequential points, with reflections on the changes occurring and how the perspectives of different stakeholders helped to define and understanding both the barriers experienced by DHH/BVI students, and the interventions that could reduce these barriers. These barriers and interventions were refined, discussed, and initial weightings added by the collaborative design focus group in the final stage of the research and became the components of the MACE framework discussed at the end of this chapter, and produced in full in chapter 6. The methods of analysis are summarised in the table below. For details of each study please refer to the section 3, Methodology.

Table 5 Data Analysis Phases

Phase	Study	Method	Analysis (Quantitative)	Analysis (Qualitative)
1	1	Survey	• Descriptive Statistics • Factor Analysis • Correlation • Non-parametric Statistics	• Thematic (iteration 1 of 3) • Content (iteration 1 of 3)
1	2	Interviews (student)		• Thematic (iteration 2 of 3) Content (iteration 2 of 3)
2	3	Interviews (staff)		
2	4	Focus Group (Workshop Format)		• Thematic (iteration 3 of 3) Content (iteration 3 of 3)
3	5	Focus Group (Collaborative Design)		

The sub-sections (level 2 headings) in this chapter relate to the phases and studies in the research reflecting this sequential and iterative analysis, and are references in the format PxSx, so P1S1 refers to Phase 1 Study 1 - Survey. At the end of each section the contributions to the final model are discussed and visualised, and the mapping of codes between phases discussed. Statistical analysis of the survey data was revisited after the workshop focus groups (P2S4) to test assumptions and hypotheses arising from the second and third iterations of qualitative analysis (interview and workshop data).

The final section in this chapter discusses the MACE framework and how this was developed with the Focus Group (Collaborative Design) in P3S5, implementing a DBR approach to evaluate the findings as part of the process.

Table 6 Findings Chapter Breakdown

Section	Contents
Survey (P1S1)	Introduction Data Preparation Survey Design Structure Statistical Analysis #1 Descriptive Statistics Statistical Analysis #2 Content Analysis #1 Thematic Analysis #1 Summary
Interviews (P1S2, P2S3)	Introduction Student Interviews Staff Interviews Thematic Analysis #2 Content Analysis #2 Summary
Focus Groups (Workshop Format) (P2S4)	Introduction Personas and Quotes Focus Group Formats Thematic Analysis #3 Content Analysis #3 Summary
Focus Group (Collaborative Design) (P3S5)	Introduction Focus Group Operation Findings and Output The Model
Chapter Summary	Summary

5.2 Survey (P1S1)

The survey was conducted online during the autumn/winter of 2019 following an initial pilot survey with 9 respondents conducted via the Disabled Students' Group Facebook page. Minor alterations were made to the questions following feedback from the DSG and respondents. The data from the full survey was analysed on completion.

5.2.1 Statistical Analysis 1 – descriptive statistics

Of the 1,065 students contacted, 327 responses were received (31%). Of these 208 (19% of sample, 86% of responses) offered to participate in further research. This sample included a high proportion of students (n=965, 91%) with declared hearing and or sight loss (hearing n=551, 52%; sight n=395, 37%; both sight and hearing n=19, 2%), as well as a selection of students for comparative purposes (n=100, 10%), and was provided by the University.

DHH/BVI

To ascertain differences between students with or without sensory impairment each respondent was classified as sighted or BVI and hearing or DHH. Classification was determined by response to questions ID 60 "*How would you describe your sight?*" and ID 61 "*How would you describe your hearing?*", by the description provided in ID 84 "*Please add any additional comments on your hearing/sight impairment here if you want to*", and by the SRPP records of declared disability in ID 100 "*Hearing*" and ID 105 "*Sight*". The process of classification is explained below.

For the research, students were also asked to declare their own level of impairment (if any) and indicate whether they used BSL, Braille, or lip read. The survey asked participants to describe their hearing and sight levels (ID 60 and ID 61). Responses are shown in Table 7 and Table 8.

Table 7 ID 60

		Frequency	Percent	Valid Percent
Valid	Perfect hearing	44	13.5	16.4
	Generally OK	39	11.9	14.6
	Hearing problems in some environments	36	11.0	13.4
	Corrected by hearing aid	47	14.4	17.5
	Partially corrected by hearing aid	74	22.6	27.6
	Very limited hearing	18	5.5	6.7
	Profoundly deaf	10	3.1	3.7
	Total	268	82.0	100.0
Missing	System	59	18.0	
Total		327	100.0	

Table 8 ID 61

		Frequency	Percent	Valid Percent
Valid	Perfect vision	27	8.3	10.0
	Generally ok	32	9.8	11.9
	Corrected by glasses	111	33.9	41.1
	Partially corrected by glasses	39	11.9	14.4
	Limited vision	49	15.0	18.1
	Blind	12	3.7	4.4
	Total	270	82.6	100.0
Missing	System	57	17.4	

Total		327	100.0	

The survey also provided the option to describe their hearing/sight level in their own words if preferred (ID 84), so whilst some responses were missing to ID 60 and ID 61, derived data and broader groupings of hearing/DHH and sighted/VI took these responses into account by utilising the description provided to categorise respondents. In addition, declarations of disability to the University ID 100 and ID 105 allowed further respondents to be categorised.

Hence the statistics for ID 114 ("*VLG – Visual Level Group*") and ID 115 ("*HLG – Hearing Level Group*") in *Table 9 Hearing/DHH* and *Table 10 Sighted/BVI.*

Table 9 Hearing/DHH

		Frequency	Percent
Valid	DHH	208	63.6
	Hearing	83	25.4
	Total	291	89.0
Missing	NA	36	11.0
Total		327	100.0

Table 10 Sighted/BVI

		Frequency	Percent
Valid	BVI	125	38.2
	Sighted	170	52.0
	Total	295	90.2
Missing	NA	32	9.8
Total		327	100.0

ID 116 "*SI Grouping*" classified participants into the four mutually exclusive groups.

Table 11 SI Grouping

		Frequency	Percent
Valid	No SI	26	8.0
	DHH Only	176	53.8
	BVI Only	93	28.4
	Dual SI	32	9.8
	Total	327	100.0

In summation, there were three sources of data used for this classification: the SRPP disability classification (ID 100 and ID105), the selected level of impairment from the survey (ID 60 and ID 61), and the self-defined level of impairment from the open text response (ID 84). Where no SI was selected or declared, and qualitative data did not indicate impairment, participants were classified as "No SI".

DHH and/or BVI students had additional disabilities declared in the provided data. This BVI and DHH classification was combined with the University held data on disability (ID 98 to ID 108) to evaluate both levels of declaration in hearing/sight loss, and combinations of disability which added levels of complexity to the interpretation of the data. This potential impact on the findings of multiple disabilities in revisited in the discussions chapter.

Table 12 DHH and Other Declared Disabilities

	DHH
Autistic spectrum	2
Fatigue/Pain	12
Manual Skills	2
Mental Health	17
Mobility	12
Speech	1
Unseen	9
Sight	21
Dyslexia/specific	7
Other	2
Total DHH	208

Table 13 BVI and other declared disabilities

	BVI
Autistic spectrum	0
Fatigue/Pain	14
Manual Skills	5
Mental Health	11
Mobility	18
Speech	4
Unseen	11
Hearing	12
Dyslexia/specific	5
Other	5
Total BVI	125

Of the DHH students 89 used lip reading and 11 use BSL as their primary mode of communication.

Of the 100 questionnaire respondents with visual impairment only 3 use Braille.

General Demographics

Some general demographical statistics were created to provide background to the survey respondents and allow comparisons between the DHH/hearing and BVI/sighted groups. Age, ethnicity and gender were examined.

Table 14 Valid Data Demographics

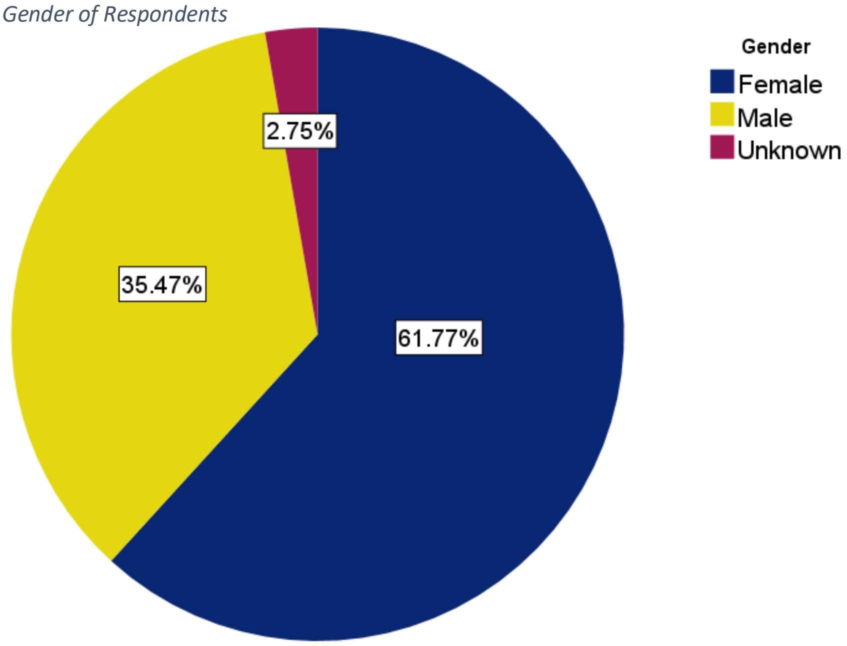
		sex	ethnicity	age
N	Valid	318	318	318
	Missing	9	9	9
Total		327	327	327

There was a significantly higher proportion of female (61.77%) to male (35.47%) respondents, but this was a similar proportion to the contacts provided by SRPP (Female 62.9%, Male 37.1%), and does reflect the general student population statistics of the OU (female 62.2% , Male 37.7%).[13]

Table 15 Gender

	Frequency	Percent
Unknown	9	2.75%
Female	202	61.77%
Male	116	35.47%
Total	327	100.0

Figure 8 Gender of Respondents



Ethnicity of students in the survey was predominantly white, with marginally less diversity than the OU population figures for 2019 (the period during which the survey was undertaken) indicating that the proportions were broadly representative of the OU population as a whole. In terms of representation of the UK population the 2011 census (most recent available data) indicated that 87% of people in the UK are White, and 13% belong to a Black, Asian, Mixed or Other ethnic group (2011 Census data, https://www.ethnicity-facts-figures.service.gov.uk/). Again, the survey sample generally reflects the OU population and the population in the UK.

[13] https://www.hesa.ac.uk/data-and-analysis/students/where-study#provider (Accessed: 29/09/2022 09:27)

Ethnicity

Table 16 Ethnicity - Survey

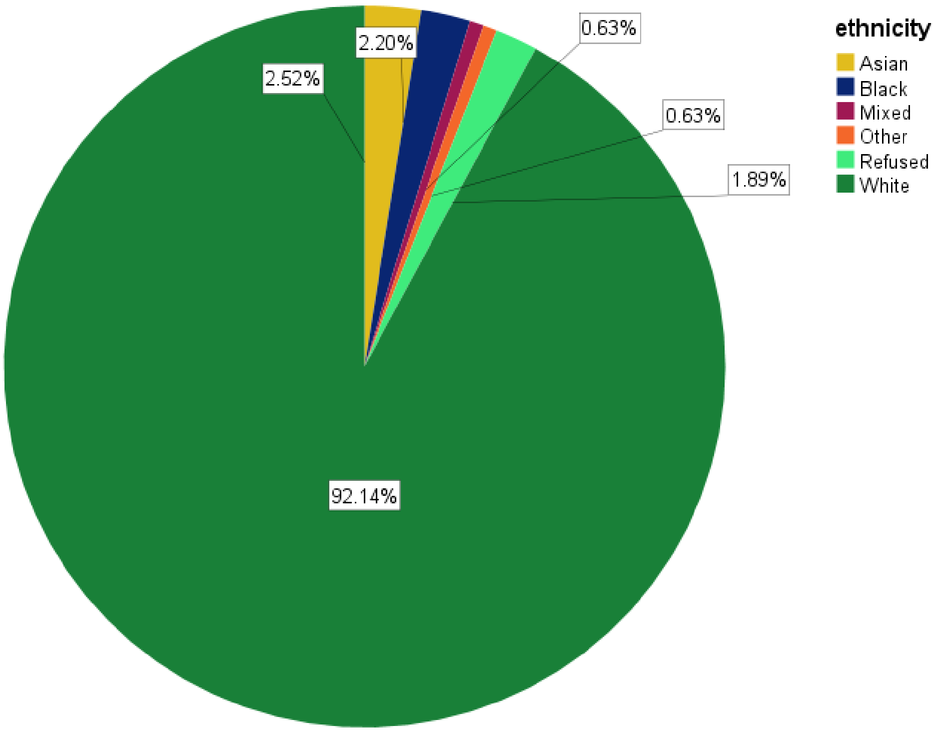
Ethnicity	Student	Percentage
Asian	8	2.52%
Black	7	2.20%
Mixed	2	0.63%
Other	2	0.63%
Unknown	6	1.89%
White	293	92.14%
Total	318	100.00%

OU (2019)

Table 17 Ethnicity - OU 2019

Ethnicity	Student	Percentage
Asian	8,152	3.83%
Black	8,141	3.82%
Mixed	5,041	2.37%
Other	1,754	0.82%
Unknown	4,134	1.94%
White	185,754	87.22%
Total	212,976	100.00%

Figure 9 Ethnicity of Respondents



Distribution of students' study across faculties (see Table 18 Faculty) was also explored as some subject areas were more likely to have collaborative activities as part of the assessed module content. In Science, Technology, Engineering, and Maths (STEM) this regularly included field trips, experiments, and laboratory-based activities (both remote and online). The Faculty of Business and Law (FBL) was less likely to include collaborative activities.

Table 18 Faculty

	Frequency	Percent
Unknown	9	2.8
FASS (Faculty of Art and Social Sciences)	125	38.2
FBL (Faculty of Business and Law)	32	9.8
LTI (Learning and Teaching Initiative)	11	3.4
STEM (Science, Technology, Engineering and Maths)	88	26.9
WELS (Wellbeing, Education, Languages and Sport)	62	19.0
Total	327	100.0

The SRPP data provided included the module that the student was currently enrolled on (or the first module listed where the student was studying more than one module). This was used to associate a survey response with a faculty. This provides a general reflection of the study at one point, but students may during the duration of their time at the OU, study units at different faculties and many are working towards an 'Open' degree not restricted to modules in a single faculty.

As hearing and sight loss can be age-related[14] the distribution of DHH and BVI students was also explored.

Looking initially at all participants, these were from across the adult age spectrum, ranging from 19 to 88 years, with a mean age of 45.8 and standard deviation of 15.96. This mean age is higher than that of the OU student population as a whole (currently 27), but comparable with the SRPP sample. Comparing hearing/DHH and sighted/BVI there was no significant difference in the age range or distribution, and there is no indication of age-related hearing or sight loss being the pervading factor in DHH and BVI students.

[14] https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/disability/adhocs/008285personswithdifficultyhearingbyemploymentstatusoccupationgroupagegroupandregion2008to2017 (Accessed: 29/09/2022 09:24)

Figure 10 Age Distribution - All respondents

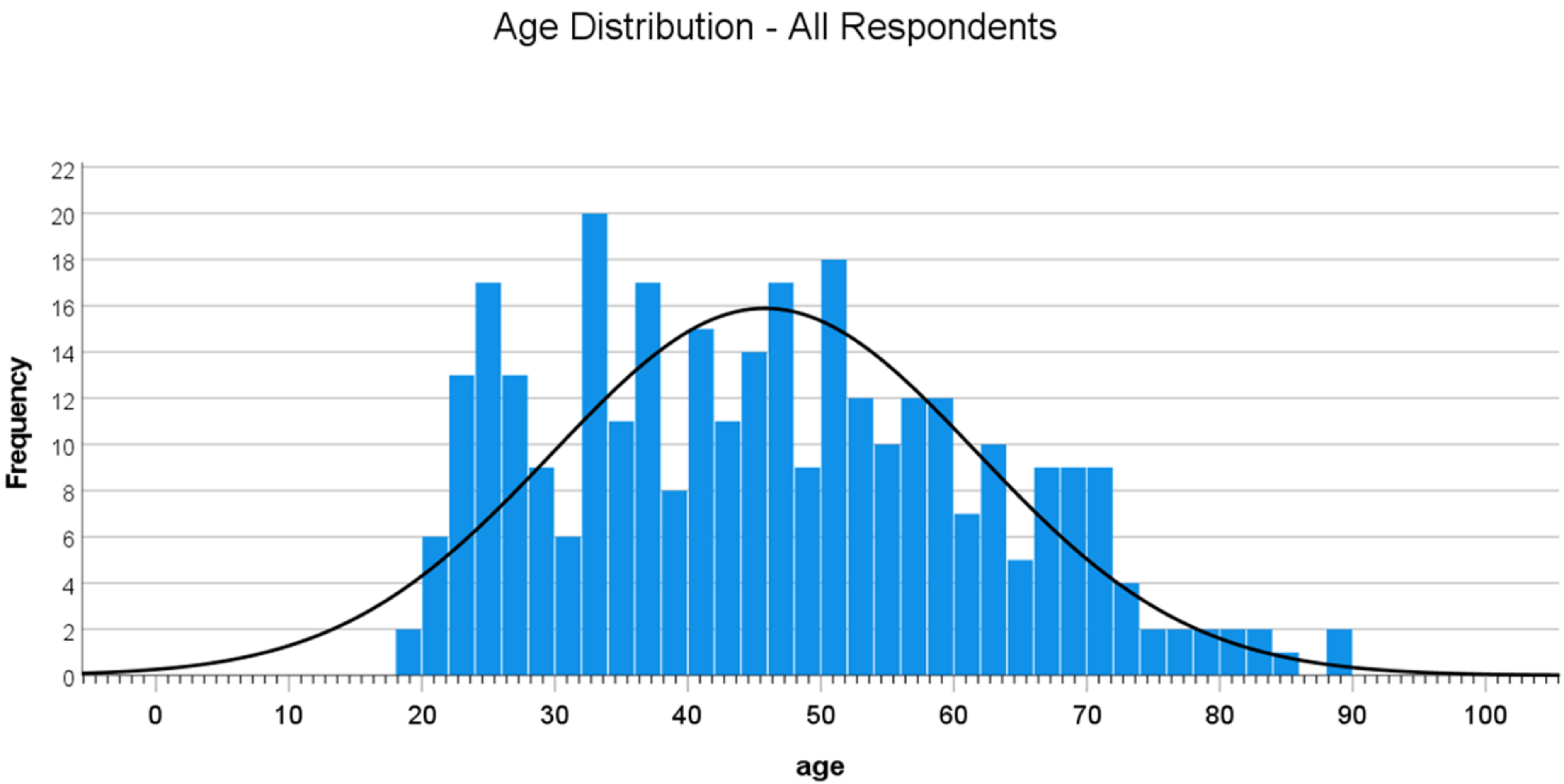


Figure 11 Age Distribution -DHH/Hearing

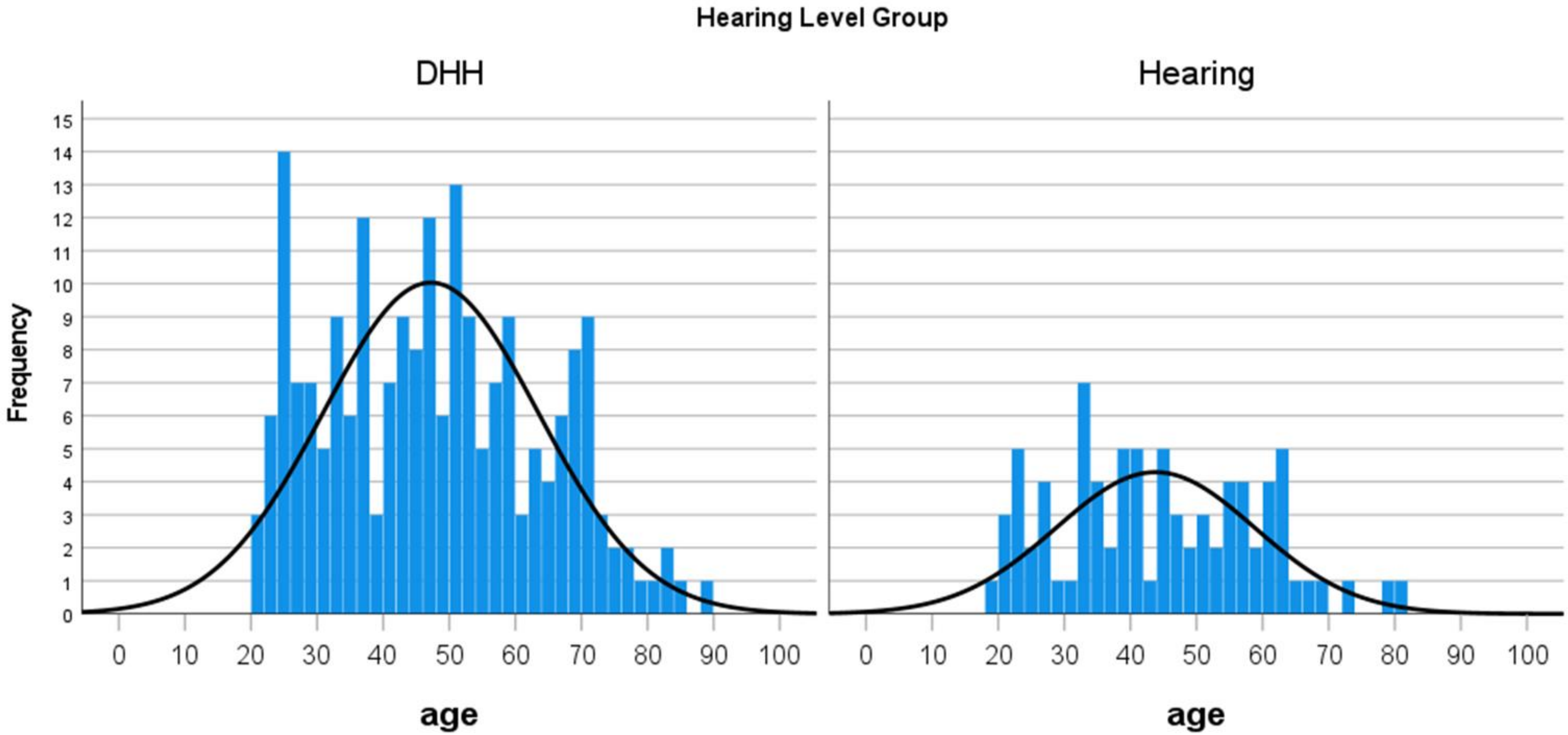
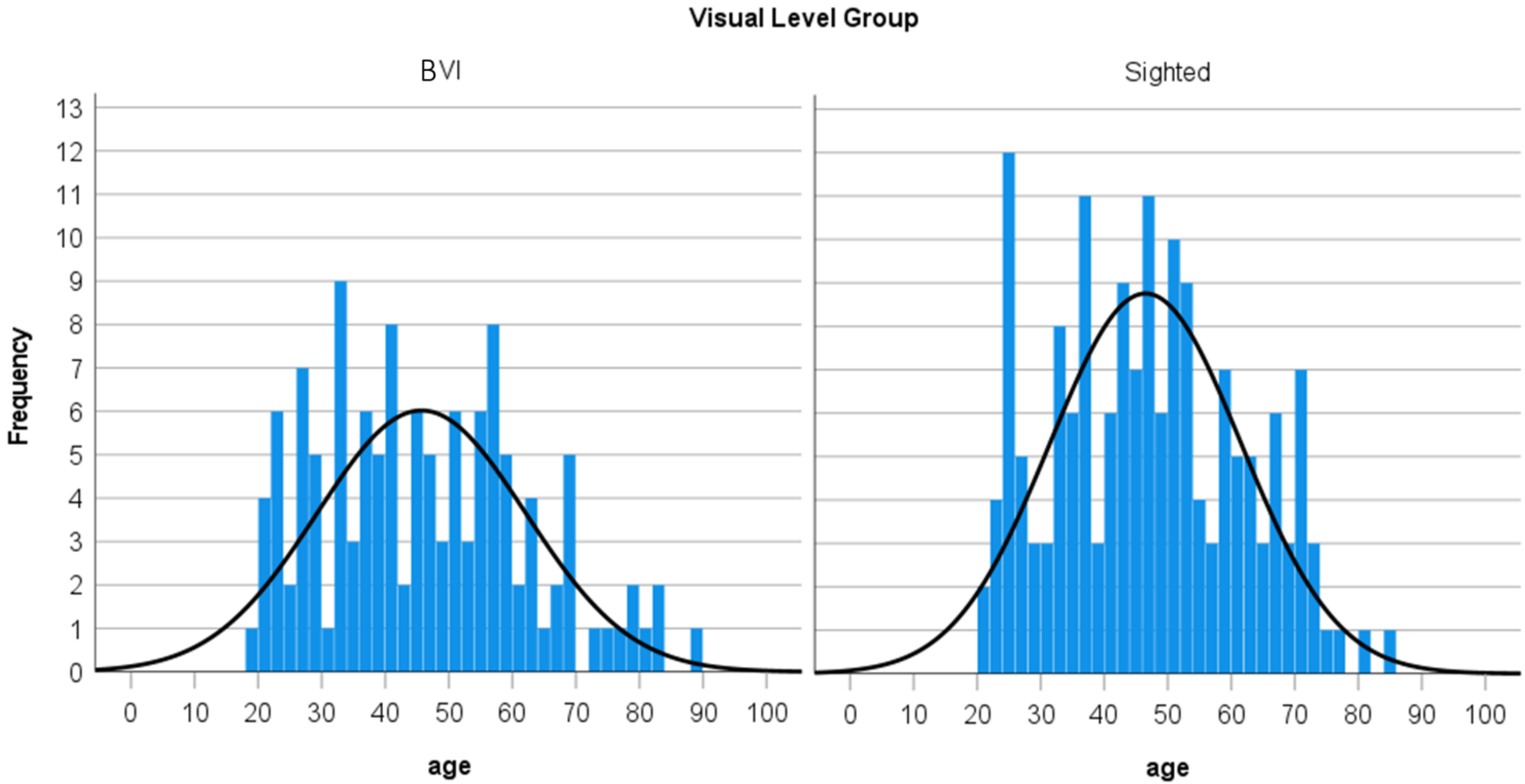


Figure 12 Age Distribution - BVI/Sighted



#

Hearing/DHH were comparable as were sighted/BVI.

Table 19 Age Distribution - BVI

Visual Level Group		N	Minimum	Maximum	Mean	Std. Deviation
BVI	age	99	19	83	46.33	16.363
	Valid N (listwise)	99				

Table 20 Age Distribution - Sighted

Visual Level Group		N	Minimum	Maximum	Mean	Std. Deviation
Sighted	age	165	20	85	46.52	15.034
	Valid N (listwise)	165				

Table 21 Age Distribution - DHH

Hearing Level Group		N	Minimum	Maximum	Mean	Std. Deviation
DHH	age	205	20	88	47.21	16.299
	Valid N (listwise)	205				

Table 22 Age Distribution - Hearing

Hearing Level Group		N	Minimum	Maximum	Mean	Std. Deviation
Hearing	age	81	19	80	43.81	15.057
	Valid N (listwise)	81				

Table 23 Age Distribution - Sighted and Hearing

		N	Minimum	Maximum	Mean	Std. Deviation
Sighted + Hearing	age	14	23	66	44.86	14.464
	Valid N (listwise)	14				

Using an independent samples t-test confirmed that there was no significant difference in the mean age values for DHH students (n=205, M=47.21, Std. Deviation=16.299) and hearing ones (n=81, M=43.81, Std. Deviation=15.057) with t=-1.621 and p=0.106. Similarly, with BVI students (n=124, M=45.71, Std. Deviation=16.43) and sighted ones (n=165, M=46.52, Std. Deviation=15.034) with t=-0.433 and p=0.665. Although the mean age of both the SRPP sample and the survey respondents was higher than that of the OU student population, as there is no significant difference in age distribution between hearing/DHH and sighted/BVI age was not considered a confounding factor in the research in terms of impairment but has to be considered in terms of representation of the student population as a whole. This is considered further in the discussions chapter.

The general statistics here provided an overview of the demographics of the participants and how representative they were of the general population within the OU. What emerged from this statistical analysis was that aside from sensory impairment the sample was broadly representative of the student population.

The survey data was revisited at the end of phase 2 of the research, where a more detailed analysis of the survey responses was carried out.

5.3 Statistical analysis – End of P2

After qualitative data was collected from phases 1 and 2 of the research the quantitative data from the survey was revisited to determine whether the results supported the outcomes of the thematic and content analysis.

On completion of the four studies in the first two phases of the research the quantitative data from the survey was revisited to triangulate statistical data from the closed questions and Likert scaled responses, with the thematic analysis of the open, qualitative responses. A clear picture emerged of a body of students that were being excluded from the collaborative online experience.

In addition, the provided data was reviewed to evaluate potential bias in the sample provided by SRPP in relation to the respondents.

Sample Data Analysis

The qualitative analysis had suggested that SI students might be opting out of modules because of perceived barriers associated with required collaborative work. It was possible to explore withdrawals from modules within the SRPP sample group and the survey respondents. This indicated that BVI/DHH students were more likely to withdraw from modules than sighted/hearing students. Whilst is it not possible to infer the reasons for withdrawal from the data it does indicate that withdrawal was more likely.

- Of the 3852 modules taken by hearing/sighted students there were 490 (12.72%) withdrawals
- Of the 1729 modules taken by BVI students there were 337 (19.49%) withdrawals
- Of the 2122 modules taken by DHH students there were 346 (15.64%) withdrawals
- Of the 95 modules taken by BVI and DHH students there were 26 (27.37%) withdrawals

These suggest dual-sensory impaired students have a significant withdrawal rate, and that both DHH and BVI students have withdrawal rates above those of hearing/sighted students.

Table 24 Sample - Student Count

		DHH		
		N	Y	Total
BVI	**N**	1035	551	1586
	Y	395	19	414
Total		1430	570	2000

Table 25 Sample – Student Percentage

		DHH		
		N	Y	Total
BVI	**N**	51.75%	27.55%	**79.3%**
	Y	19.75%	0.95%	**20.7%**
Total		**71.5%**	**28.5%**	**100%**

Table 26 Sample - Modules Taken Count

		DHH		
		N	Y	Total
BVI	**N**	3852	2212	6064
	Y	1729	95	1824
Total		5581	2307	7888

Table 27 Sample - Modules Completed Count

		DHH		
		N	Y	Total
BVI	**N**	2327	1315	3642
	Y	996	50	1046
Total		3323	1365	4688

Table 28 Sample - Module Withdrawals Count

		DHH		
		N	Y	Total
BVI	**N**	490	346	836
	Y	337	26	363
Total		827	372	1119

Table 29 Sample - Module Withdrawals Percentage

		DHH		
		N	Y	% Total
BVI	**N**	12.72%	15.64%	13.79%
	Y	19.49%	27.37%	19.90%
% Total		14.82%	16.12%	14.18%

Survey

Each of the survey sections (online tutorials, face-to-face tutorials, forums, wikis and group work) contained a number of questions exploring experience which required a scaled response these were evaluated numerically:

1= strongly disagree

2=disagree

3=neither agree nor disagree

4=agree

5=strongly agree

Mean scores of Hearing/DHH and Sighted/VI, and the four SI grouping categories were explored to see if there were areas of difference than might indicate problems and warrant deeper exploration in subsequent studies.

Independent-samples t-tests were used to compare the mean score of the two different groups of students. A t-test needed one categorical, independent variable (in this instance DHH/Hearing for one set of tests and BVI/Sighted for another), and one continuous, dependent variable (in these instances the responses to the Likert scaled questions). ANOVA tests were then performed against the same questions using the SI Grouping.

This choice of statistical evaluation has the limitations as discussed in section 3.7.3 that the Likert values are presumed to be at regular intervals on a continuous scale.

Information contained in the t-test tables is as follows: ID is the question ID as detailed in appendix (b) and full question text is also provided in the ANOVA tables within each section. The group statistics for each of the two different groups (DHH/Hearing, BVI/Sighted) are then provided in the first set of columns. For each group the number of respondents within in each group is given, along with the mean and the standard deviation (recorded as n, Mean and Std. Deviation respectively). The results of Levene's Test for Equality of Variance are shown in the next two columns which test whether the variance (variation) of the scores for the two groups (DHH and Hearing, or BVI and Sighted) is the same. The outcome of this test determined which of the t values was appropriate to use. If the Sig. value here is larger than 0.05 then equal variance was assumed, if not then the variance of the two groups is not the same and so equal variance is not assumed and the t value that compensates for this was used.

The final set of columns shows the results of the t-tests for equality of means. If the value in the p column (2 tailed significance) is less than or equal to 0.05 then this indicates a significant difference in the mean scores on the dependent variable for the two groups (i.e. the Likert scaled question). If the value is above 0.05 then this indicates that no significant difference was found.

Where significant difference was found the results have been highlighted and discussed below the tables.

For the ANOVA tests a single table for each survey section is provided showing the p values for the ANOVA tests. Where there was a significance difference indicated by a p value (Sig.) less than or equal to 0.05 the full ANOVA results, descriptive statistics and multiple comparisons are provided to illustrate where the differences among the groups occur.

Where there were Yes/No questions, such as question 17 "*Have you attended a face-to-face tutorial at the OU?*" a Chi-Squared test for independence was used to evaluate the responses from the groups (e.g. DHH and Hearing). The Chi-Squared tests initially required a check to ensure that the minimum expected cell frequencies were valid. Cross tabulation of the question responses against the group were recorded and the Chi-squared value calculated. As these factors have a two-by-two table (i.e. each variable has only two categories) Yates' Correction for Continuity was used for the Chi-square test. If the value is < 0.05 then there is a significant statistical difference.

5.3.1 Online Tutorials

Question 2 "*have you attended an online tutorial at the OU*" indicated that DHH students (n=208, No=40.9%, Yes=59.1%) were less likely to attend an online tutorial than hearing ones (n=83, No=25.3%, Yes=74.7%). A Chi-Squared Test for Independence (with Yates' Continuity Correction) indicated a significance between DHH and Hearing students in terms of online tutorial attendance: $\chi 2$ (1, n=291) = 0.018. There was no significant difference between the groups for question 3 "*have you listened to a recording of an online tutorial at the OU*" for this group: $\chi 2$ (1, n=291) = 0.572, suggesting that it is the live situations that DHH students are opting out of. There was no significant difference in responses to these questions when comparing BVI and Sighted students.

t-Tests

Analysis of the results of the Likert scale questions regarding online tutorials is shown in the tables below.

Table 30 DHH/Hearing Online Tutorials Likert Scale Responses

	DHH			Hearing			Levene's Test		t-Test							
ID	N	Mean	Std. Deviation	N	Mean	Std. Deviation	F	Sig.	t	df	p	Mean Difference	Error Difference	Lower	Upper	Sig Diff
4	176	3.69	1.296	81	3.94	1.065	6.717	0.010	-1.635	186.594	0.104	-0.251	0.153	-0.553	0.052	N
5	167	3.15	1.378	76	2.86	1.383	0.000	0.998	1.542	241	0.124	0.294	0.191	-0.082	0.670	N
6	174	3.11	1.332	81	3.31	1.357	0.004	0.948	-1.107	253	0.270	-0.199	0.180	-0.554	0.155	N
7	166	3.69	1.287	78	3.62	1.360	1.244	0.266	0.430	242	0.668	0.077	0.180	-0.277	0.432	Y
8	167	3.80	1.301	79	3.04	1.652	17.125	0.000	3.588	125.425	0.000	0.758	0.211	0.340	1.177	N
9	171	3.15	1.318	79	3.33	1.278	0.094	0.759	-1.030	248	0.304	-0.183	0.178	-0.533	0.167	N
10	169	3.98	1.139	78	4.08	1.148	0.119	0.731	-0.644	245	0.520	-0.101	0.156	-0.408	0.207	N
11	170	3.44	1.230	78	3.41	1.294	0.331	0.565	0.146	246	0.884	0.025	0.171	-0.312	0.362	N
12	169	3.36	1.251	79	3.57	1.356	1.247	0.265	-1.191	246	0.235	-0.209	0.175	-0.554	0.136	N

Table 31 BVI/Sighted Online Tutorials Likert Scale Responses

	BVI			Sighted			Levene's Test		t-Test							
ID	N	Mean	Std. Deviation	N	Mean	Std. Deviation	F	Sig.	t	df	p	Mean Difference	Error Difference	Lower	Upper	Sig Diff
4	102	3.98	1.043	160	3.68	1.276	5.912	0.016	2.072	244.289	0.039	0.299	0.144	0.015	0.584	Y
5	96	3.01	1.403	152	3.03	1.376	0.116	0.734	-0.088	246	0.930	-0.016	0.181	-0.372	0.340	N
6	101	3.25	1.315	158	3.20	1.330	0.355	0.552	0.267	257	0.790	0.045	0.169	-0.287	0.377	N
7	100	3.64	1.411	150	3.68	1.217	4.912	0.028	-0.239	248	0.811	-0.040	0.168	-0.370	0.290	N
8	101	3.06	1.648	150	3.84	1.221	27.736	0.000	-4.067	171.824	0.000	-0.781	0.192	-1.159	-0.402	Y
9	103	3.27	1.308	153	3.20	1.284	0.045	0.833	0.420	254	0.675	0.069	0.165	-0.255	0.394	N
10	100	4.06	1.188	153	3.95	1.123	0.800	0.372	0.760	251	0.448	0.112	0.148	-0.179	0.403	N
11	99	3.42	1.302	155	3.43	1.195	1.158	0.283	-0.010	252	0.992	-0.002	0.159	-0.315	0.312	N
12	152	3.34	1.261	101	3.56	1.299	0.261	0.610	1.356	251	0.176	0.222	0.164	-0.101	0.545	N

For question 4 "*I find online tutorials very helpful*" there was a significant difference in scores for BVI (M=3.98, Std. Deviation=1.043) and Sighted (M=3.68, Std. Deviation=1.276), where t=2.072 and p=0.039, indicating that BVI students find online tutorials more helpful than sighted ones. For DHH students the mean was lower (3.69) than that of hearing (3.94), suggesting less of a preference for online tutorials but with no significant statistical difference.

For question 8 "*I prefer to type rather than talk during online tutorials*" there was significant difference in scores for DHH (M= 3.8, Std. Deviation = 1.301) and Hearing (M=3.04, Std. Deviation=1.652), where t=3.588 and p= 0.668, indicating that DHH students expressed a greater desire to type rather than talk during online tutorials than hearing students. This suggests a preference for non-verbal communications from DHH students. This preference was reversed for BVI/Sighted comparison, with BVI (M=3.06, Std. Deviation=1.648) against Sighted (M=3.84, Std. Deviation=1.22 and t=-4.067, p=0) indicating a preference for talking over typing. These findings suggest a difference in perspective between the two sensory impaired groups.

ANOVA Tests

Table 32 ANOVA – Between Group Significance - Online Tutorials

ID	Online tutorials	Sig.
4	I find online tutorials very helpful	0.157
5	I prefer to watch recordings of tutorials rather than attend live sessions	0.350
6	I find online tutorials easy to follow	0.329
7	I prefer to listen rather than talk during online tutorials	0.966
8	I prefer to type rather than talk during online tutorials	<0.001
9	I like to join in with discussions	0.408
10	I like to hear what other students have to say	0.775
11	I like to take part in activities	0.809
12	I enjoy working with other students	0.418

The only question where ANOVA suggested a possible statistical difference was ID8 "*I prefer to type rather than talk during online tutorials*". This violated the Levene test for homogeneity of variances so the Welch and Brown-Forstythe tests were consulted. These also showed a significance of <0.001 so no conclusions were possible.

5.3.2 Face-to-face Tutorials

There was no significance between DHH (n=183, No=45.9%, Yes=54.1%) and Hearing students (n=76, No=47.4%, Yes=52.6%) in response to question 17 "*Have you attended a face-to-face tutorial at the OU?"* with $\chi 2$ (1, n=259) = 0.937. This was also true for BVI (n=99, No=50.5%, Yes=49.5%) and Sighted (n=164, No=43.9%, Yes=56.1%) students, with $\chi 2$ (1, n=263) = 0.361.

t-Tests

Table 33 DHH/Hearing Face-to-face Tutorial Likert Scale Responses

	DHH			Hearing			Levene's Test		t-Test							
ID	N	Mean	Std. Deviation	N	Mean	Std. Deviation	F	Sig.	t	df	p	Mean Difference	Error Difference	Lower	Upper	Sig Diff
18	105	3.33	1.291	44	3.05	1.555	4.971	0.027	1.082	69.062	0.283	0.288	0.266	-0.243	0.819	N
19	104	4.36	0.954	44	4.11	1.243	5.078	0.026	1.156	65.432	0.252	0.242	0.209	-0.176	0.660	N
20	106	3.17	1.424	44	3.80	1.503	0.518	0.473	-2.410	148	0.017	-0.626	0.260	-1.139	-0.113	Y
21	105	4.12	0.978	43	4.05	1.133	1.366	0.244	0.417	146	0.678	0.077	0.186	-0.289	0.444	N
22	106	3.72	1.233	44	3.20	1.519	5.474	0.021	1.984	67.660	0.051	0.512	0.258	-0.003	1.028	N
23	105	3.99	1.164	42	4.19	1.174	0.012	0.913	-0.939	145	0.349	-0.200	0.213	-0.621	0.221	N
24	105	4.03	1.087	42	3.83	1.305	3.728	0.055	0.928	145	0.355	0.195	0.210	-0.221	0.611	N
25	105	4.01	1.139	42	4.00	1.082	0.355	0.552	0.046	145	0.963	0.010	0.205	-0.396	0.415	N

Table 34 BVI/Sighted Face-to-face Likert Scale Responses

	BVI			Sighted			Levene's Test		t-Test							
ID	N	Mean	Std. Deviation	N	Mean	Std. Deviation	F	Sig.	t	df	p	Mean Difference	Error Difference	Lower	Upper	Sig Diff
18	56	3.20	1.470	96	3.26	1.324	2.089	0.150	-0.276	150	0.783	-0.064	0.232	-0.522	0.394	N
19	55	4.09	1.266	96	4.34	0.904	11.074	0.001	-1.303	85.996	0.196	-0.253	0.194	-0.639	0.133	N
20	57	3.44	1.593	96	3.35	1.369	5.499	0.020	0.334	104.085	0.739	0.084	0.253	-0.417	0.586	N
21	55	4.02	1.209	96	4.13	0.909	3.997	0.047	-0.569	89.296	0.571	-0.107	0.188	-0.480	0.266	N
22	56	3.21	1.498	96	3.73	1.192	5.668	0.019	-2.198	95.574	0.030	-0.515	0.234	-0.980	-0.050	Y
23	54	4.06	1.323	96	3.99	1.091	4.060	0.046	0.312	93.601	0.756	0.066	0.212	-0.354	0.486	N
24	54	3.83	1.342	96	4.04	1.035	9.827	0.002	-0.987	88.854	0.326	-0.208	0.211	-0.628	0.211	N
25	54	3.98	1.141	96	3.97	1.156	0.557	0.457	0.065	148	0.948	0.013	0.196	-0.374	0.399	N

Interestingly there was a preference from DHH students for attending online tutorials despite qualitative evidence to the contrary. For question 20 "*I find it easier to attend online tutorials*" there was a significant difference in scores for DHH (n=106, M=3.17, Std. Deviation=1.424) and Sighted (n=44, M=3.8, Std. Deviation=1.503), where t=-2.41 and p=0.017, indicating that DHH students were less likely to find it easier to attend online tutorials than face-to-face. On reflection this question should have included "*than face-to-face*" so could have been open to misinterpretation.

In question 22 "*I find it easier to access face-to-face tutorials*" there was a significant difference, t=-2.198 and p=0.03, for BVI students (M=3.21, Std. Deviation=1.498) than sighted ones (M=3.73, Std. Deviation=1.192) indicating that BVI students found it harder to access face-to-face tutorials. This could be related to the nature of face-to-face tutorials at the Open University being located at different sites which were likely to be unfamiliar to BVI students and therefore perhaps difficult to physically negotiate and potentially require assistance to access.

ANOVA Tests

Table 35 ANOVA – Between Group Significance - Face-to-Face Tutorials

ID	**Face-to-face tutorials**	**Sig.**
18	The locations of face-to-face tutorials are convenient for me	0.446
19	I find face-to-face tutorials very helpful	0.296
20	I find it easier to attend online tutorials	0.097
21	I find face-to-face tutorials easy to follow	0.763
22	I find it easy to access face-to-face tutorials	0.066
23	I like to join in with discussions	0.899
24	I like to take part in activities	0.683
25	I enjoy working with other students	0.872

No significant differences were found in response to the face-to-face tutorial responses for the ANOVA tests.

5.3.3 Forums

There were no significant differences in response to question 27 "*Have you used online forums at the OU?*" between either of the two groups with the majority of students using forums. DHH (n=185, No=9.7%, Yes=90.3%) and Hearing (n=82, No=3.7%, Yes=96.3%), with $\chi2$ (1, n=267) = 0.146. BVI (n=99, No=8.1%, Yes=91.9%) and Sighted (n=167, No=7.8%, Yes=92.2%), with $\chi2$ (1, n=266) = 1.

t-Tests

Table 36 DHH/Hearing Forums LIkert Scale Responses

	DHH			Hearing			Levene's Test		t-Test							
ID	N	Mean	Std. Deviation	N	Mean	Std. Deviation	F	Sig.	t	df	p	Mean Difference	Error Difference	Lower	Upper	Sig Diff
31	169	2.70	1.138	74	2.69	1.181	0.214	0.644	0.056	241	0.955	0.009	0.160	-0.307	0.325	N
32	170	2.82	1.092	76	2.87	1.087	0.002	0.962	-0.338	244	0.736	-0.051	0.150	-0.347	0.246	N
33	171	3.03	1.124	76	3.00	1.166	0.387	0.535	0.187	245	0.852	0.029	0.157	-0.280	0.338	N
34	169	3.57	1.056	76	3.42	1.225	2.414	0.122	0.958	243	0.339	0.147	0.153	-0.155	0.449	N
35	169	4.04	1.002	77	4.03	1.147	2.406	0.122	0.107	244	0.915	0.015	0.144	-0.269	0.300	N
36	168	3.79	1.056	75	3.75	0.988	0.139	0.710	0.272	241	0.786	0.039	0.144	-0.244	0.322	N
37	168	3.46	1.049	77	3.42	1.229	3.427	0.065	0.319	243	0.750	0.049	0.153	-0.252	0.349	N
38	170	3.21	1.198	77	3.12	1.337	1.837	0.177	0.556	245	0.579	0.095	0.171	-0.241	0.431	N
39	170	2.33	1.336	77	2.61	1.506	3.756	0.054	-1.471	245	0.143	-0.281	0.191	-0.657	0.095	N

Table 37 BVI/Sighted Forums Likert Scale Responses

	BVI			Sighted			Levene's Test		t-Test							
ID	N	Mean	Std. Deviation	N	Mean	Std. Deviation	F	Sig.	t	df	p	Mean Difference	Error Difference	Lower	Upper	Sig Diff
31	90	2.68	1.198	154	2.75	1.135	0.473	0.492	-0.449	242	0.654	-0.069	0.154	-0.372	0.234	N
32	91	2.81	1.154	156	2.86	1.080	1.164	0.282	-0.313	245	0.754	-0.046	0.146	-0.334	0.242	N
33	92	2.86	1.263	156	3.13	1.054	7.099	0.008	-1.764	164.77	0.080	-0.276	0.156	-0.585	0.033	N
34	91	3.46	1.195	155	3.56	1.063	1.649	0.200	-0.678	244	0.498	-0.100	0.147	-0.390	0.190	N
35	93	4.10	1.074	154	3.99	1.019	0.557	0.456	0.756	245	0.450	0.103	0.137	-0.166	0.372	N
36	89	3.90	0.942	155	3.70	1.065	3.660	0.057	1.487	242	0.138	0.202	0.136	-0.066	0.470	N
37	90	3.41	1.198	156	3.49	1.063	2.491	0.116	-0.559	244	0.576	-0.082	0.147	-0.373	0.208	N
38	92	3.12	1.308	156	3.23	1.207	1.200	0.274	-0.679	246	0.498	-0.111	0.164	-0.434	0.211	N
39	93	2.63	1.538	155	2.26	1.278	9.505	0.002	1.984	166.96	0.049	0.376	0.190	0.002	0.751	Y

In questions regarding forums there was more consistency across the groups, the only significant difference being in regard to questions 39 "*I find forums difficult to navigate*" with this being true for more BVI students (M=2.63, Std. Deviation=1.538) than sighted ones (M=2.26, Std. Deviation=1.278) with t=1.984 and p=0.049. As both of these means are some of the lowest in the dataset it suggests a universal difficulty navigating forums that is perhaps exacerbated by visual impairment.

ANOVA Tests

Table 38 ANOVA – Between Group Significance - Forums

ID	**Forums**	**Sig.**
31	I like to pose questions on forums	0.895
32	I like to answer questions on forums	0.607
33	I like to add to discussions on forums	0.128
34	I find forums a good source of information	0.690
35	I prefer to get information from the module materials	0.411
36	I prefer to get information from my tutor	0.169
37	Forums are a good way to create links with other students	0.829
38	Forums help me feel part of a student group	0.874
39	I find forums difficult to navigate	0.205

No significant differences were found in response to the face-to-face tutorial responses for the ANOVA tests.

5.3.4 Wikis

There were no significant differences in response to question 40 "*Have you used wikis at the OU?*" between either of the two groups with the majority of students not using wikis. DHH (n=168, No=69.6%, Yes=30.4%) and Hearing (n=76, No=67.1%, Yes=32.9%), with χ2 (1, n=244) = 0.146. BVI (n=90, No=65.6%, Yes=34.4%) and Sighted (n=156, No=71.2%, Yes=28.8%), with χ2 (1, n=246) = 0.308.

t-Tests

Table 39 DHH/Hearing Wikis Likert Scale Responses

	DHH			Hearing			Levene's Test		t-Test							
ID	N	Mean	Std. Deviation	N	Mean	Std. Deviation	F	Sig.	t	df	p	Mean Difference	Error Difference	Lower	Upper	Sig Diff
44	54	2.61	1.338	23	3.30	1.259	0.003	0.954	-2.117	75	0.038	-0.693	0.327	-1.346	-0.041	Y
45	55	3.29	1.286	23	3.70	1.063	0.944	0.334	-1.330	76	0.188	-0.405	0.304	-1.011	0.202	N
46	56	2.82	1.177	23	2.78	1.204	0.334	0.565	0.132	77	0.895	0.039	0.293	-0.546	0.623	N
47	55	2.95	1.239	24	3.25	1.189	0.158	0.692	-1.017	77	0.312	-0.305	0.299	-0.901	0.292	N
48	55	2.87	1.348	23	3.04	1.186	0.574	0.451	-0.528	76	0.599	-0.171	0.324	-0.815	0.474	N
49	54	2.85	1.265	23	3.17	1.114	0.206	0.652	-1.058	75	0.293	-0.322	0.304	-0.929	0.284	N

Table 40 BVI/Sighted Wikis Likert Scale Responses

	BVI			Sighted			Levene's Test		t-Test							
ID	N	Mean	Std. Deviation	N	Mean	Std. Deviation	F	Sig.	t	df	p	Mean Difference	Error Difference	Lower	Upper	Sig Diff
44	30	3.00	1.365	47	2.70	1.334	0.022	0.883	0.947	75	0.347	0.298	0.314	-0.329	0.924	N
45	32	3.59	1.241	46	3.24	1.233	0.133	0.716	1.246	76	0.216	0.355	0.284	-0.212	0.921	N
46	32	3.19	1.230	47	2.49	1.019	1.750	0.190	2.748	77	0.007	0.698	0.254	0.192	1.204	Y
47	32	3.09	1.228	47	3.00	1.234	0.083	0.774	0.332	77	0.741	0.094	0.282	-0.468	0.656	N
48	31	2.97	1.329	47	2.91	1.265	0.289	0.593	0.177	76	0.860	0.053	0.299	-0.542	0.648	N
49	30	3.03	1.217	47	2.91	1.213	0.219	0.641	0.417	75	0.678	0.118	0.284	-0.447	0.684	N

Wikis had the fewest respondents with a number of students unaware of their use or function having not encountered them on modules. This showed significant differences between the groups in question 44 "*I enjoy producing a wiki with other students*" for DHH students (M=2.61, Std. Deviation=1.338) indicating less enjoyment than hearing students (M=3.3, Std. Deviation=1.259) with t=-2.117 and p=0.038. BVI students had a higher mean for this question (M=3, Std. Deviation=1.365) than sighted students (M=2.7, Std. Deviation=1.334) but with no significance shown in the t-Test (t=0.947, p=0.347). Reasons for this are not clear at this stage, but number of respondents is relatively low so the results may have no significance.

ANOVA Tests

Table 41 ANOVA – Between Group Significance - Wikis

ID	**Wikis**	**Sig.**
44	I enjoy producing a wiki with other students	0.354
45	I don't like editing others work	0.354
46	I find it difficult to edit and contribute	0.009
47	I find the end product useful	0.479
48	I find the process useful	0.937
49	Producing a wiki helps consolidate ideas	0.676

ID46 "*I find it difficult to edit and contribute*" showed an ANOVA significance of 0.009. Multiple comparisons revealed that there was a statistically significant difference in mean scores between at least two groups (F(3,76)=[4.159], p=0.009). Tukey's HSD test for multiple comparisons found that the mean value was significantly different between 'No SI' and 'Duel SI' (p=0.028, 95% CI =[-3/96, -0.16]), between 'DHH Only' and 'Duel SI' (p=0.018, 95% CI=[-2.11, -15]), and 'Duel SI' and 'No SI' ([=0.028, 95% CI=[-2.11, -0.15]). This suggests that students with duel SI find it harder to edit and contribute to wikis.

Table 42 ANOVA - ID46

ANOVA					
I find it difficult to edit and contribute (wiki)					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15.342	3	5.114	4.159	.009
Within Groups	93.458	76	1.230		
Total	108.800	79			

Table 43 ANOVA - Multiple Comparisons - ID46

Multiple Comparisons

Dependent Variable: I find it difficult to edit and contribute (wiki)

Tukey HSD

(I) SI Grouping	(J) SI Grouping	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
No SI	DHH Only	-.933	.661	.496	-2.67	.80
	BVI Only	-1.238	.684	.277	-3.04	.56
	Duel SI	-2.061*	.722	.028	-3.96	-.16
DHH Only	No SI	.933	.661	.496	-.80	2.67
	BVI Only	-.305	.293	.727	-1.07	.47
	Duel SI	-1.127*	.373	.018	-2.11	-.15
BVI Only	No SI	1.238	.684	.277	-.56	3.04
	DHH Only	.305	.293	.727	-.47	1.07
	Duel SI	-.823	.413	.200	-1.91	.26
Duel SI	No SI	2.061*	.722	.028	.16	3.96
	DHH Only	1.127*	.373	.018	.15	2.11
	BVI Only	.823	.413	.200	-.26	1.91

*. The mean difference is significant at the 0.05 level.

Table 44 ANOVA - Descriptives - ID46

Descriptives										
I find it difficult to edit and contribute (wiki)										
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between-Component Variance
						Lower Bound	Upper Bound			
No SI		3	1.67	.577	.333	.23	3.10	1	2	
DHH Only		45	2.60	1.074	.160	2.28	2.92	1	5	
BVI Only		21	2.90	1.179	.257	2.37	3.44	1	5	
Duel SI		11	3.73	1.191	.359	2.93	4.53	1	5	
Total		80	2.80	1.174	.131	2.54	3.06	1	5	
Model	Fixed Effects			1.109	.124	2.55	3.05			
	Random Effects				.339	1.72	3.88			.245

5.3.5 Group work

t-Tests

Table 45 DHH/Hearing Group Work Likert Scale Responses

	DHH			Hearing			Levene's Test		t-Test							
ID	N	Mean	Std. Deviation	N	Mean	Std. Deviation	F	Sig.	t	df	p	Mean Difference	Error Difference	Lower	Upper	Sig Diff
52	75	3.29	1.292	32	3.34	1.473	1.151	0.286	-0.177	105	0.860	-0.050	0.285	-0.615	0.514	N
53	75	3.11	1.331	31	3.26	1.390	0.080	0.778	-0.526	104	0.600	-0.151	0.288	-0.722	0.420	N
54	76	3.36	1.219	32	3.19	1.469	3.267	0.074	0.614	106	0.541	0.168	0.273	-0.374	0.710	N
55	77	4.03	1.076	31	3.74	1.154	0.045	0.833	1.216	106	0.227	0.284	0.234	-0.179	0.747	N
56	74	2.34	1.174	29	2.07	1.307	0.262	0.610	1.012	101	0.314	0.269	0.266	-0.258	0.796	N
57	74	3.03	1.334	31	2.58	1.311	0.037	0.847	1.572	103	0.119	0.446	0.284	-0.117	1.010	N

Table 46 BVI/Sighted Group Work Likert Scale Responses

	BVI			Sighted			Levene's Test		t-Test							
ID	N	Mean	Std. Deviation	N	Mean	Std. Deviation	F	Sig.	t	df	p	Mean Difference	Error Difference	Lower	Upper	Sig Diff
52	38	3.53	1.330	69	3.19	1.342	0.001	0.975	1.250	105	0.214	0.338	0.270	-0.198	0.874	N
53	37	3.16	1.344	69	3.12	1.334	0.071	0.791	0.170	104	0.866	0.046	0.273	-0.494	0.587	N
54	38	3.37	1.324	70	3.27	1.284	0.085	0.771	0.371	106	0.712	0.097	0.262	-0.422	0.616	N
55	38	3.87	1.189	70	3.99	1.056	0.100	0.752	-0.527	106	0.599	-0.117	0.223	-0.559	0.324	N
56	36	2.19	1.305	67	2.28	1.165	1.272	0.262	-0.355	101	0.723	-0.089	0.251	-0.587	0.409	N
57	38	2.84	1.326	67	2.96	1.331	0.047	0.828	-0.419	103	0.676	-0.113	0.270	-0.648	0.422	N

In general group work there were no significant differences in either of the groups evaluated.

ANOVA Tests

Table 47 ANOVA – Between Group Significance - Group Work

ID	**Group work**	**Sig.**
52	I find group work useful	0.118
53	I enjoy working with other students on projects	0.569
54	I think group work is an important part of study	0.087
55	I prefer to work on my own	0.759
56	I avoid modules that involve group work	0.015
57	I find it difficult to participate with group work	0.031

ID56 “I avoid modules that involve group work” showed an ANOVA significance of 0.015. Multiple comparisons revealed that there was a statistically significant difference in mean scores between at least two groups (F(3,100)=[3.683], p=0.015). Tukey’s HSD test for multiple comparisons found that the mean value was significantly different between ‘BVI Only’ and ‘Duel SI’ (p=0.028, 95% CI =[-2.19, -0.09])/‘Duel SI’ and ‘BVI Only’ ([=0.028, 95% CI=[0/09, -2.19]).

Table 48 ANOVA - ID56

ANOVA

I avoid modules that involve group work

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14.925	3	4.975	3.683	.015
Within Groups	135.066	100	1.351		
Total	149.990	103			

Table 49 ANOVA - Multiple Comparisons - ID56

Multiple Comparisons

Dependent Variable: I avoid modules that involve group work

Tukey HSD

(I) SI Grouping	(J) SI Grouping	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
No SI	DHH Only	.787	.464	.331	-.42	2.00
	BVI Only	1.217	.502	.079	-.09	2.53
	Duel SI	.077	.545	.999	-1.35	1.50
DHH Only	No SI	-.787	.464	.331	-2.00	.42
	BVI Only	.431	.284	.433	-.31	1.17
	Duel SI	-.710	.355	.195	-1.64	.22
BVI Only	No SI	-1.217	.502	.079	-2.53	.09
	DHH Only	-.431	.284	.433	-1.17	.31
	Duel SI	-1.140*	.403	.028	-2.19	-.09
Duel SI	No SI	-.077	.545	.999	-1.50	1.35
	DHH Only	.710	.355	.195	-.22	1.64
	BVI Only	1.140*	.403	.028	.09	2.19

*. The mean difference is significant at the 0.05 level.

Table 50 ANOVA - Descriptives - ID56

Descriptives										
I avoid modules that involve group work										
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between-Component Variance
						Lower Bound	Upper Bound			
No SI		7	3.00	1.414	.535	1.69	4.31	1	5	
DHH Only		61	2.21	1.112	.142	1.93	2.50	1	5	
BVI Only		23	1.78	1.126	.235	1.30	2.27	1	5	
Duel SI		13	2.92	1.320	.366	2.13	3.72	1	5	
Total		104	2.26	1.207	.118	2.02	2.49	1	5	
Model	Fixed Effects			1.162	.114	2.03	2.49			
	Random Effects				.294	1.32	3.20			.178

ID57 “I find it difficult to participate with group work” showed an ANOVA significance of 0.031. Multiple comparisons revealed that there was a statistically significant difference in mean scores between at least two groups (F(3,102)=[3.086], p=0.031). Tukey’s HSD test for multiple comparisons found that the mean value was significantly different between ‘BVI Only’ and ‘Duel SI’ (p=0.022, 95% CI =[-2.45, -0.14])/‘Duel SI’ and ‘BVI Only’ ([=0.022, 95% CI=[0.14, 2.45]).

Table 51 ANOVA - ID57

ANOVA

I find it difficult to participate with group work

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15.464	3	5.155	3.086	.031
Within Groups	170.395	102	1.671		
Total	185.858	105			

Table 52 ANOVA - Multiple Comparisons - ID57

Multiple Comparisons

Dependent Variable: I find it difficult to participate with group work

Tukey HSD

(I) SI Grouping	(J) SI Grouping	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
No SI	DHH Only	.400	.516	.865	-.95	1.75
	BVI Only	.886	.553	.382	-.56	2.33
	Duel SI	-.407	.606	.908	-1.99	1.18
DHH Only	No SI	-.400	.516	.865	-1.75	.95
	BVI Only	.485	.307	.394	-.32	1.29
	Duel SI	-.807	.395	.179	-1.84	.22
BVI Only	No SI	-.886	.553	.382	-2.33	.56
	DHH Only	-.485	.307	.394	-1.29	.32
	Duel SI	-1.292*	.442	.022	-2.45	-.14
Duel SI	No SI	.407	.606	.908	-1.18	1.99
	DHH Only	.807	.395	.179	-.22	1.84
	BVI Only	1.292*	.442	.022	.14	2.45

*. The mean difference is significant at the 0.05 level.

Table 53 ANOVA - Descriptives - ID57

Descriptives

I find it difficult to participate with group work

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between-Component Variance
						Lower Bound	Upper Bound			
No SI		7	3.29	1.113	.421	2.26	4.31	2	5	
DHH Only		61	2.89	1.367	.175	2.54	3.24	1	5	
BVI Only		25	2.40	1.291	.258	1.87	2.93	1	5	
Duel SI		13	3.69	.947	.263	3.12	4.26	2	5	
Total		106	2.90	1.330	.129	2.64	3.15	1	5	
Model	Fixed Effects			1.292	.126	2.65	3.15			
	Random Effects				.288	1.98	3.81			.166

Of the 291 responses to ID64 ("*I lip read*"), of which 208 were DHH, 89 stated that they lip read. This represents 30.58% of respondents and 42.79% of DHH respondents.

The statistical analysis of the survey data broadly supported the findings of the qualitative analysis.

5.3.1 Thematic and Content Analysis 1 – initial themes and hypotheses

Following the descriptive statistical analysis of the quantitative demographic fields, content analysis and thematic analysis of the qualitive data was undertaken.

Thematic Analysis

The first pass Thematic Analysis (TA) of the data involved implementation of the first two phases of Braun and Clarke's approach to TA, familiarisation with the data and coding. Whereas the familiarisation phase involves engaging with the data, the coding is more systematic. Braun and Clarke suggest that with the familiarisation process there are two seemingly contradictory practices: immersion in the data (developing deep and intimate knowledge of your dataset) which implies a closeness and familiarity, and critically engaging with the information or data which involves distancing (Braun and Clarke, 2022). In this familiarisation process the responses were read grouped by individual and also by question so that the consistency and story of the individual could be understood and the more generalised response to the different areas under question. This enable both processes to be undertaken with the first read allowing immersion in the data and the second allowing a more critical engagement.

Familiarisation with the data.

Qualitative data was analysed from the responses to all of the open comment questions:

Table 54 Fields Used for Qualitative Analysis

ID	Question
	online tutorials
13	If not, what are your reasons for not attending/watching?
15	If YES, please explain briefly the access problems you had.
16	Do you have any further comments about online tutorials?
	face-to-face tutorial
26	Do you have any further comments about face-to-face tutorials?
	forums and wikis
50	Do you have any further comments about forums and wikis?
	group work
58	Please explain any difficulties you have had with group work
59	Do you have any further comments about group work?
	Other
	If you have a visual and/or hearing impairment have you had any problems accessing the services and tools you need for your study at the OU?

78	If YES please explain
	Tick all that apply. Have you experienced difficulties in attending tutorials or joining in group activities relating to your: Sight, Hearing, Use of assistive technology, Other
83	If so please briefly explain the problems
84	Please add any additional comments on your hearing/sight impairment here if you want to
85	What questions do you think we should be asking about experiences of students with hearing and/or sight impairment?
86	Is there anything else you would like to add?

Each completed survey response was individually read in full. Data from the open questions was then extracted, imported into NVivo and print-outs of the collated responses to each individual question produced. The first look and familiarisation phase of the thematic analysis was completed with a readthrough of all of the responses to each question. Note-taking was undertaken throughout the thematic analysis at every stage and iteration covering general observations, reflections, expected and unexpected responses to the questions. Items of interest and comments that might benefit from further probing during P1S2 were noted.

There followed a more analytical process of coding the data. When it came to the analytical coding, the responses to each question were worked through systematically identifying segments of data that appeared potentially interesting, relevant to the research areas in general, and specifically meaningful to the research questions. Chosen codes and code labels were adjusted and refined throughout the process with the aim of capturing within each code a single meaning or concept. Since reflective TA was used this was at a range of levels from the semantic (explicit or surface) to the latent (conceptual or implicit). For phase 3 of the process where the initial themes were generated these codes were examined to identify shared patterned meaning or core ideas which would help to form an answer to the research questions. This process sometimes involved redefining or interpreting the code and reallocation between initial themes. There is a natural overlap between the themes and they are certainly not mutually exclusive so this redefining and re-thinking of codes fed into the areas that needed further exploration or development in the subsequent phases of the research. This happened at each of the three stages of the thematic analysis.

The data highlighted a number of frustrations and observations from students that were outside the scope of this research, such as those relating to administrative systems, specific people, or isolated personal incidences. In these cases, if the incidents had no identifiable connection to tutorials or collaborative activities they were excluded from the coding. Whilst this information might lead to a more general understanding of a specific student's frustrations or experienced barriers, they were not considered observations that could contribute to an understanding of either the barriers to engagement or interventions to reduce these barriers. It is acknowledged that this implies a filtering of the information on the part of the researcher.

After coding the survey responses both content and thematic analysis was performed on the coded data. The codes were grouped into four main categories covering the 36 codes and a content analysis performed to evaluate the frequency and importance of different codes. The thematic analysis enabled an understanding of how these codes were derived and interpretation of the core issues arising.

Reflection on the Readthrough

What became clear from the initial readthrough of survey responses was the diversity of student experiences. As well as different levels of hearing and/or sight impairments, there were different aids, tools and equipment, and different adjustments requested or suggested. These ranged from the profoundly deaf students use of BSL as their first language and reliance on translation and interpretation to participate, to those with minimal hearing loss having difficulty keeping up and following the conversation through mishearing. Similarly blind students who relied on screen readers to follow tutorials were frustrated by the lack of screen readable components and the difficulty in obtaining slides in advance. Students with visual impairments varied greatly in the tools they used, some relying on magnification, large font sizes and screen zooming, with others only reading the screen through assistive technologies such as screen reading software which translates visual information to voice/sound to make sense of what is on screen. Access to materials in advance was a major concern for many of these students. In general, there was a range of modes and tools of communication.

First pass codes

Codes were initially created by focussing on responses that related to barriers to engagement or participation but including other repeated motifs. These were then categorised into the broader themes (categories) that emerged and re-evaluated on a second pass utilising the existing codes, hence the analysis was both inductive and deductive. Coded responses were identified and categorised as a positive or negative statement where appropriate. A second categorisation process was implemented in parallel to look at learning environments and delivery formats represented by each survey section, and again these were classified where appropriate as positive and negative responses.

Themes Identified

Four categories and 35 themes were generated. Four main categories were identified and then themes were given a provisional link to a category based on closest match as some of the original codes/themes spanned more than one category. Table 55 summarises the refined and sorted barrier related themes and categories from the phase 1 thematic analysis.

The following section of the findings is organised by the four main categories and for each the related codes (themes) that are examined. Each section starts with a content analysis of the category, followed by descriptions and sample quotes from each of the codes/themes and then a discussion on the findings for each theme.

Table 55 Categories and Codes

Category	Codes/Themes
Communication	• Navigating Screen • Online Chat • Lip Reading • Screen Reading • Seeing People • Sound problems • Transcripts and Captions • Unable to Follow/Join In/Participate • Unable to Hear
Emotional and Social	• Anxiety • Concentration • Confidence • Declaration of Disability • Disability Awareness • Embarrassment • Opting Out • Stress/Frustration
Technical and Provisioning	• Access to Support/Resources • Assistive Technology (General) • Complexity of Technology • Familiarity with Tech and Platform • Learning Platform (AC) • Recordings • Session Access (Online) • Speed and Pace • Technology Failure/Problems • Venue Access and Location (F2F)
Activity and Session Design	• Activity Design • Dissemination of Information • Group Size • Shared Materials • Text Size/Colour • Tutor Response and Awareness • Tutor Understanding of Accessibility

Content Analysis

To evaluate the frequency and importance of each code as well as to evaluate bias, prejudice or inconsistencies, the content analysis looked at the number of references to each code within the survey data, the positive and negative responses to the themes and the number of different respondents referenced in each theme. This ensured that a theme was not the result of repeated references from a single or small number of respondents relative to the total number of references. In addition, the coded text was evaluated in terms of the category of respondent – BVI, DHH, both BVI and DHH, and the comparative group (hearing and sighted). This provided a perspective on which research group was most impacted by the theme and whether this impact was positive or negative.

The number of positive and negative comments in each section of the survey are shown in Table 56.

Table 56 Section Survey Content Analysis

	Number of Responses	Positives	Negatives
Online Tutorials	286	13	246
Face-to-face Tutorials	137	6	74
Forums and Wikis	89	1	17
Group Work	132	6	25
Access	246	5	180
General	213	10	20

The content analysis revealed that online tutorials received the most negative responses 86% of the 286 coded responses, compared to face-to-face with 54%, forums and wikis with 19% and group work with 19%.

Content analysis was performed on each of the coded themes.

All content analysis tables have the following headings:

1. Refs — Total statements coded to theme
2. Positives — Number of positive sentiments
3. Negatives — Number of negative sentiments
4. Respondents — Number of different respondents in coded theme
5. BVI — Number of responses from Blind/Visually Impaired students
6. DHH — Number of responses from Deaf/Hard of Hearing students
7. BVI&DHH — Number of responses from students who are both DHH and BVI
8. Comparative — Number from students who are hearing and sighted (Comparative Group).

For a content analysis example explanation: with "*Unable to follow/participate*", as illustrated in Table 57, there were 37 coded references in the survey responses to the open text questions. Of these none were positive and 29 were negative (so 8 were not categorised as either). These 37 coded references came from 31 different respondents. Of these 37 references 14 were BVI students, 27 were DHH students, 5 were both BVI and DHH and 1 was neither BVI nor DHH. Where a student is both BVI and DHH they were included in all three categories. Another way of representing this would have been to exclude the students classified as BVI&DHH from the independent BVI and DHH categories which would classify 9 as BVI and 22 as DHH and 5 as both BVI and DHH. It was decided to classify the students that were BVI&DHH in all three groups so that BVI and DHH can be explored independently.

The following sections report on the content and thematic analysis for each of these four categories of codes.

Communications

Content Analysis

Table 57 Communications Themes - Content Analysis

Themes	**1. Refs**	**2. Positives**	**3. Negatives**	**4. Respondents**	**5. BVI**	**6. DHH**	**7. BVI&DHH**	**8. Comparison**
Navigating Screen	24	0	21	20	22	5	3	0
Online Chat	6	1	4	5	5	2	1	0
Lip Reading	10	0	2	10	0	10	0	0
Screen Reading	20	0	13	13	20	3	3	0
Seeing People	11	1	1	11	1	10	0	0
Sound problems	68	0	54	54	9	62	4	1
Transcripts and Captions	31	3	17	28	2	31	2	0
Unable to Follow/Participate	37	0	29	31	14	27	5	1
Unable to Hear	45	0	27	39	2	44	1	0

In all categories the ratio of references to respondents was low indicating that there was a good spread of respondents in each code. Screen reading was the highest ratio here with only 13 respondents for the 20 references giving a ratio of 1:1.54

Unsurprisingly there were a huge number of DHH students whose main area of concern with communications was being unable to hear. This resulted in 45 mostly negative comments from 39 different respondents with nearly all of these respondents being DHH. General sound problems were raised by both DHH and BVI students, but again the significant proportion of these were DHH. Barriers to participation were expressed by both BVI and DHH students.

Problems with navigating the screen were identified by predominately BVI students (22/25). There was an interesting spread of both BVI and DHH students unable to follow/participate with 37 references (29 negative) from 31 different respondents of whom 14 were BVI and 27 DHH suggesting barriers for both groups. There were 2 responses in the comparative group indicating that other students potentially had navigational problems.

Thematic Analysis

Table 58 Communication Themes

Themes	Sample Quotes
Navigating Screen	“Have had issues due to the order of the buttons slightly changing and so more keystrokes are required of a different order causing some confusion on my part and so failing to get the session to work adequately well- usually means I cannot get my mic to work.” (1997, BVI) “Cannot see the tutorial system easily, text box too small to actively participate. With screen magnifier I can obviously only focus on part of the screen at one time” (1997, BVI) “The site can be a bit difficult to navigate on terms of finding information.... particularly the library. I am actually registered as a blind person so navigating is quite stressful” (2029, BVI) “At one point I could not unmute my own microphone because I could not navigate to the right area with the keyboard. On one occasion I couldn't do anything due to a pop-up in Adobe Connect that I could neither read nor dismiss.” (1780, BVI) “Accessing the different features such as raising a hand or activating the microphone is difficult” (1997 BVI)
Online Chat	(Using screen reading software) “It's hard for me to follow the chat as the whole contents of the chat window are read each time.” (1780, BVI) “The size of the chat box makes it difficult for me to contribute” (1978, BVI&DHH) “I find the chat box too small if I alter font the box is too small to follow conversation.” (1856 BVI)
Lip Reading	“I use a mixture of hearing, lip reading, context to work out what is being said. For this I need to see the face of the speaker. Sound through computers, headphones etc. does not have the clarity I need.” (1806, DHH) “People have a tendency to either cover their mouths or turn away making it difficult to augment my hearing with lip reading” (1936, DHH) “I have a hearing problem and use lip reading or an app that only works with my phone. Without video I find it hard to follow and the tutorials are not useful on my phone as the screen is too small to see slides” (1819, DHH)
Screen Reading	“Screen readers don't always work with the materials. Tutors sometimes expect us to read new material very fast.” (2121, BVI&DHH) “Submit buttons for online forums are not announced by JAWS and so I cannot use the forums at all without assistance from a sighted person in my room at home.” (BVI, 1967) “Adobe connect doesn’t work well with my screen reader, so I have to make do with what remaining vision I have, meaning I can’t use the chat box properly, struggle with adobe connect’s more complex functions, and have to receive the slideshows in advance in order to know what each slide is.” (1842, BVI) “Visually I find them very difficult with screen reader things can be too quick I struggle to know what is going on. In real time they are very difficult.” (1981, BVI)
Seeing People	“online tutorials/exercises are disjointed as speakers have to be chosen by the tutor, making it less easy to follow - there is no lip reading and no visual cues which makes online tutorials harder than face-to-face tutorials” (1813, DHH)

	“Face to face much better. I can usually get a helpful hand when faced with having to read some handed out document! I obviously carry a multitude of gadgets... but.... being a member of a class you can sense how others are really coping.” (1880, BVI) “My high frequency hearing loss is so severe that no hearing aid has been able to help. I use a mixture of hearing, lip reading, context to work out what is being said. For this I need to see the face of the speaker. Sound through computers, headphones etc. does not have the clarity I need.” (1806, DHH)
Sound Problems	“it can be hard working with others as time is often needed to understand voice differences.” (1951, DHH) “I struggle with accents/dialect and have to get someone to speak/listen on my behalf.” (2116, DHH) “it’s been about the noise interference or the person talking too quietly or the sound going up and down” (2028, DHH) “More than one person talking at any time means I will probably not understand what is said.” (1779, DHH) “Noise interference, person taking tutorials may move around making it difficult to hear, not speaking clearly, background noises” (2028, DHH) “Occasionally the sound quality of a tutor's speech can be an obstacle. Ironically it tends to occur if the microphone volume is turned up, causing distortions in the transmission and making it hard for me to understand.” (1917, DHH) “I can feel dizzy from different sounds created by microphone because I am not used to it.” (1921, DHH) “I frequently find sound confusing and in due course severely irritating. I am not an angry person but am moved to rage if sound becomes a stressor. I have had to leave tutorials early due to sound problems - some technically, and others format based. It can be isolating.” (1951, DHH) “If there are two sounds occurring at the same time, for instance, two people talking at the same time or music being played over someone talking for dramatic effect in a recording, I find it difficult to follow.” (1917, DHH) “Usually general background noise overwhelming hearing aids. Other conversations drowning out tutor's voice.” (1831, DHH) “I will always be dependent on clear articulated (not exaggerated) speaking and a relatively stable and quiet environment in order to benefit from teaching/tutorials.” (2093, DHH) “Most tutorials have been held in noisy rooms with a lot of echo - a killer for hearing aids.” 1831, DHH) “if there are a lot of voices I cannot pick up individual ones it just all becomes white noise. even with a hearing aid where you tune out some of it, I still don’t hear well and it makes me very anxious.” (1840, DHH) “I do struggle with my hearing even with my hearing aids in. Certain sounds or voices I can't hear at all, if there’s too much noise or more than one person talking it's just muffled noise and I don’t have a clue.” (1889, BVI&DHH) “When two or three students talk all at the same time, I find it impossible to clearly understand them.” (1866, DHH)
Transcriptions and Captions	“I have a preference to having subtitles, although I can hear I do tend to feel I missed things so I have subtitles to ensure this plus I can't note take whilst I’m trying to listen.” (2084, DHH) “Some of the audio and video resources do not contain subtitles. Although I can access the transcripts it means that I am unable to follow the recording in real time, so in essence it is just like using one of the readers to get information.” (2108, DHH) “Lack of closed captions or transcript on online tutorial recordings can be an issue - real-time closed captions would be amazing... Slow handwriting also means poor note taking ability.” (2101, DHH)

	"My cochlear implants link up with my computer via Bluetooth to give me louder/clearer sound but it's not enough. I really need subtitles or immediate transcripts of what is being said." (1923, DHH)
Unable to follow/participate	"Online tutorials can be very loud when people participate and I cannot keep track of what is happening and miss out on potentially vital information" (1902, DHH) "Adobe Connect has some accessibility issues. They don't generally prevent me from attending tutorials, but they do limit the extent to which I am able to participate." (1780, BVI) "I am unable to interact with other participants verbally and in writing while in the Adobe Connect system." (2139. BVI) "With my hearing difficulties I find it hard to keep up with live tutorials and find myself getting lost as to what is going on" (2108, DHH) "With hearing impairment I struggle to follow conversation and therefore tend to stay quiet in group discussions." (1879, DHH) "I can access the live online tutorial session only to the extent that I can listen to what other students or my tutor talk, but I am unable to interact with them in terms of both verbal and written communications." (2139, BVI)
Unable to hear	"Sometimes in tutorials find it difficult to follow what is being said I have to have my volume up very loud which is not good for my hearing I use sub titles or transcript to follow what has been said but when I don't have this I have to listen over the tutorial a few times to make sure I have what I need" (2032, DHH) "The difficulty in working in groups is always to be able to hear in order to contribute sensibly. To miss a comment or part of an argument takes me away from participation. Background noise or comments not projected for the whole group makes group work difficult unless in an ordered environment." (2093, DHH)

Navigating Screen

The navigating screen theme categorised all references to moving around screens including identifying, accessing, consuming, and utilising screen components. BVI students identified several problems with navigating the screen online. This included both synchronous and asynchronous collaborative activities and barriers were identified in relation to the variety of tools and assistive technologies used.

Screen navigation was implemented with the use of keyboards, screen magnifiers, hand magnifiers and screen reading software. All of these resulted in problems both accessing and navigating screens in order to find information and locate screen content such as chat panes, menus and shared materials.

Using screen magnification, either with built-in software or the use of a hand magnifier, only a small area of the screen is visible at a time, so problems with navigating complex learning environments with menus, shared content, text panes, and participant panes were significantly harder for BVI students than visually scanning a full screen and identifying the area of interest. Time was needed to locate the different areas and in synchronous situations keeping up was often a problem.

The sheer quantity of material to navigate in forums was difficult without the ability to quickly 'scan' headings and comments. Identifying relevant, interesting, and useful comments was difficult and submitting responses complex.

Students talked about problems accessing and navigating to find content too, both on the module websites and within collaborative activities such as forums and wikis. Similarly accessing and running recordings of tutorials was complex.

Navigation issues also included changing the settings and accessing the set ups in the collaborative learning environment, popups appearing and not being easy to close, accessing/navigating icons (raising hand, agree/disagree, polls, and emojis), difficulty finding the cursor, and screen layouts being changed during sessions. All of these impact the students ability to contribute, especially with the time limitations inherent in a live situation. Often students 'missed bits' or found they were out of sync with everyone else.

Juggling different devices/tools/programmes when navigating a screen was also raised as a problem. For example, some tools were available on mobile devices but then some programme functionality was restricted on these devices, so access was implemented using both mobile and desktop devices. A blind student talked about using a mobile most of the time rather than a desktop as they did not require a big screen since they had no vision. Unfortunately navigating the screen with directional arrows and a screen reader did not work with the module site and software used.

When trying to participate students were hindered by slow response to selections or keyboard shortcuts requiring two hands, resulting in taking a longer time than their peers to react and engage meaning they frequently missed the opportunity to do so.

The sheer quantity of text in collaborative activities such as forums and the inability to 'skim' through the content made the tasks more complex and consumption lengthier.

Online Chat

On the collaborative learning platform online chat was the preferred mode of communication for most students, particularly the DHH students but also the main body of students. Problems encountered here related to the size and positioning of both the box and the text. The chat pane dimensions were not adjustable for students, meaning BVI students who needed to increase the font size in order to read talked of only being able to see very small amounts of text at any time and therefore needing to continuously scroll to attempt to read the chat, and encountering difficulties in re-tracing conversations and identifying contributors. The limitations placed on available font sizes and colours was also raised as an issue with some students requiring larger font sizes than offered. Whilst it was possible to change the font colour it was not possible to change the back colours resulting in some students being unable to implement their preferred colours and contrasts. There was mention of some screen reading software reading all the text every time the chat pane was selected, although this may have been specific to one specific screen reading programme as it was only mentioned by one participant.

With DHH students there was mention of how text communications were seen as secondary contributions to the conversation with voice communications taking precedence. This led to a feeling that their contributions had less worth. Students also talked about the delay in time taken to write coupled with the fast pace of some sessions leaving the text conversation out of synchronisation with the voice one.

Lip Reading

Many DHH students talked about depending on lip reading to supplement hearing, and one of their major concerns was that in online tutorials webcams were rarely used as standard practice. This meant that students were often relying on residual hearing to make sense of communications. When cameras were used there were comments about the quality of the image and the need for the speaker to be visible (close up, face on in the screen, with adequate light and contrast) and facing camera. This was repeated in the context of face-to-face where DHH students experienced tutors inadvertently covering their mouths when speaking or looking away at screens or boards.

A mixture of hearing, lip-reading and context was needed to work out what is being said which requires a lot of focus and attention, with the consensus being that it is tiring. Students talked about the intense effort needed to understand communications without the ability to read lips (see *Concentration*). Some had not realised how much they used lip reading until they experienced online sessions without the opportunity to do so.

The invisibility of the participants online also made it harder to ask to lip read whereas in face-to-face situations they were more likely to ask for people to face them when talking.

Key findings from this theme supported the statistical analysis indicating that a significant proportion of DHH students with hearing at various levels depend on lip reading. Non-use of webcams online provided the biggest barrier to lip reading with additional problems relating to lighting, positioning, and the timely identification of speakers when they were used.

Screen Reading

A larger proportion than anticipated of participants were screen reader users, primarily from the BVI group, but surprisingly also from the DHH and comparative group which needs to be considered and is returned to in the discussions chapter. One of the main barriers encountered with screen readers were them not working with the learning platform used and some of the module components. In the online rooms this meant collaboration was extremely difficult.

There were two main areas where unreadability was a significant barrier in the online environment: the platform itself and the shared content. As far as the platform was concerned this revolved around unreadable areas (or 'pods'), problems with accessing menus, controls, dialog boxes, and icons, and with screen readers losing focus. This often occurred when tutors changed layouts without warning or instigated smaller breakout rooms for group work. This necessitated having to 're-read' the screen or the screen reader being cut off mid operation.

In terms of shared content, students talked about reading issues when items such as mind maps, whiteboards, and mathematical or chemical formulae were used. This resulted in comments such as "cannot use whiteboard which tutors like to use a lot" (1786, BVI) and "inability to navigate around the system due to the lack of the necessary feedback from JAWS[15] as to what is on the screen" (2139, BVI). Many of these shared items were completely unreadable necessitating interventions

[15] Job Access With Speech, screen reading software.

from the student if they wished to participate. Often this meant declaring disability or having to explain their needs to be able to engage which led to students frequently becoming forced into a role of passive observer in the activities rather than negotiate for access. There was a general consensus that some activities designed for collaborative work online had not been designed with accessibility in mind or with an understanding of how they would potentially work or not work with a screen reader.

When accessible materials were provided in advance this seemed to improve matters, giving students a chance to familiarise themselves with the contents and therefore take a more active role in the session. However, due to the limitations of the learning platform, if the student wanted to keep the materials open it required them to navigate between two different programs using the screen reader which caused some selection/focus and reading delay problems typically "hard to navigate, slow to select options" (1947, BVI).

Seeing People

Seeing people in a face-to-face context seemed to increase the possibilities for collaboration for DHH students who found that not having visual connections with peers and tutors online severely limited their ability to engage. There was an emphasis on the reliance by DHH students on visual cues to make meaning in addition to the other available modes of communication. This was not just about being able to read lips, but also to read body languages, facial expressions and gestures. Being in a face-to-face environment was seen as much more conducive to interpreting these communications, but even BVI students talked about how "being a member of a class you can sense how others are really coping" (1880, BVI). There seemed to be more of a social, collective aspect of face-to-face learning which did not translate to online.

Mention was made of the importance of tutors understanding the needs of DHH students in a face-to-face environment and making sure that they were facing the student/not covering their mouth or turning away when talking. There was a sense of the need to 'mix up' communication methods to get effective communications.

Sound Problems

One of the key issues encountered with sounds was the general poor quality of aural communication during online synchronous sessions. This could be attributed to several possible factors such as learning platform, equipment and the ineffective usage of technology and equipment. Whatever the reasons it was clear that unless voice and audio content was clear and without distortion it was problematic for students and especially DHH students. Students talked about the problems with 'mumbling' and the importance of 'clarity of voice.' As well as the general sound quality there were other more specific sound related problems causing barriers which raised interesting issues worth considering. Distinguishing and processing voices without visual cues was problematic. This could be related to pitch (higher or lower pitched voices often being outside of the hearing range for a student), volume (different participants' voices were heard at different volumes), dialect or accent (unfamiliar accents being harder to process), and unknown voices (it was expressed that increasing familiarity with voices/people made it progressively easier to understand).

Multiple voices speaking simultaneously was exceptionally difficult with one student suggesting it "becomes white noise" (1840, DHH). In these instances, it is difficult to isolate different individuals and follow a complex set of communications.

Technological sound problems included students getting feedback affecting their hearing aids and causing distress or physical pain. Linking technology to sound (e.g. Bluetooth hearing aids) was also problematic with connections falling out or being difficult to implement. Mics being left on when other participants were speaking often causes sound problems including feedback and background noise which interfered with the clarity of the speaker's communication.

Along with the complexity and abundance of sound related issues, students talked about the need for prolonged intense focus on hearing and how this was both physically and mentally exhausting.

Face-to-face events, although not as heavily referenced, provided some barriers in relation to sound problems. Again, mumbling and clarity of voice were issues, as well as background noises and moving around, but there were also comments about the lack of hearing loops in venues (coupled with the lack of understanding of how these functioned), and of echoey and noisy rooms.

The key requirements for combatting sound related problems seemed to be clear articulation, control of contributions and a stable and quiet environment.

Transcriptions and Captions

The use of transcriptions and captioning was also the focus of a number of student comments. This was often missing from sessions and caused significant problems for the DHH students. This included live captioning of sessions, and captioning of video recordings of sessions, as well as the provision of full transcripts for recorded sessions. There were also mentions of shared module materials (videos) not been captioned.

The general view was that captions were important for recorded materials with students talking about the need to "repeat and repeat recordings to make meaning" (1830, DHH) without them. In live sessions they were rarely used, and the students expressed a need for this to be in place in order to be able to attend sessions. A number of students did not attend because captioning was not available, and therefore they could neither follow nor contribute.

Transcripts of sessions proved less useful than captions as the need to link the transcript with a speaker and the recorded content meant that coordinating and synchronising consumption of the transcript with the video was problematic.

Unable to follow/participate

Both target student groups (BVI and DHH) had problems following or participating in group activities. They talked about having trouble keeping up, missing what is said, being only able to listen, being unable to communicate, not being able to follow conversations, and delays experienced in making sense of the communications. All of these aspects led to troubles interacting with other participants and minimised their ability to engage. When they were able to follow in part this often led to apprehension relating to participation with a fear of misunderstanding owing to the communication barriers and saying something stupid or inappropriate as a result.

Screen reader users talked about issues they had following and participating in asynchronous activities online such as being unable to submit to forums and wikis when the screen reader did not recognise the commands to do so. BVI students were often not able to follow shared materials and contribute to shared resources such as whiteboards when it was not possible to interpret the content. Some managed these activities with the help of third-party support such as non-medical helpers or family members, but again this restricted their ability to contribute and there was a reliance on the availability of the third-party and delays as content was read and described between the student/third-party/other participants making timely contributions difficult.

Unable to hear

Whereas being unable to follow identified several barriers to engagement one of the most dominant ones was being unable to hear and the consequences of this were recorded separately. Students talked about the fact that they simply cannot hear the tutor, about mumbling or bad audio equipment, tuning out or stopping listening when it became too difficult, and generally having difficulty following conversations and keeping up. The responses indicated that audio communications alone were not enough, and that alternatives such as visuals and captioning were needed in online synchronous communications. When recordings were made of sessions this did enable the students to go back to those recordings and listen multiple times in order to make meaning of sections they had missed. This obviously meant no participation was possible at the point of understanding/making meaning. Many DHH students became effectively passive observers.

As with the *sound problems* theme, different accents and pitches made it more difficult to hear and hearing aid amplifications seemed to cause indiscriminate problems.

Emotional and Social

Content Analysis

Table 59 Emotional and Social Factors - Content Analysis

Themes	1. Refs	2. Positives	3. Negatives	4. Respondents	5. BVI	6. DHH	7. BVI&DHH	8. Comparison
Anxiety	16	0	9	14	5	13	2	0
Concentration	9	0	4	8	2	8	1	0
Confidence	19	0	10	13	5	14	1	1
Declaration of Disability	10	0	5	7	6	5	1	0
Disability Awareness	3	0	0	2	1	2	0	0
Embarrassment	6	0	5	6	2	5	1	0
Opting Out	45	0	29	35	18	33	7	1
Stress/Frustration	14	0	11	12	5	9	0	0

Negative emotional responses were experienced by both BVI and DHH students and the ones recorded were those specifically linked to disability. The most significant was that of *opting out* with 45 references from 35 respondents. These came from both BVI (18) and DHH (33). Throughout the Emotional and Social content analysis there is generally proportional distributions between BVI and DHH for each theme.

Table 60 Emotional and Social Themes

Themes	**Sample Quotes**
Anxiety	"I feel very much the 'thick' person in the class and tutorials as they happen terrify me. I feel out of place, struggle to hear and am afraid to make comments in case I look stupid." (1840, DHH) "I also struggle with anxiety which presents its own difficulties in group environments and being unable to hear feeds into that." (2037, DHH) "I will always be scared that I will need to hear" (2142, DHH)
Concentration	"Being hard of hearing means I have to concentrate as hard on hearing as on the subject matter." (2066, DHH) "With full flow discussions, the speech delivery is too fast for me to be able to keep up with & understand what is being said" (1923, DHH) "One thing that is an issue for me is the level of concentration I need to complete the same task as a sighted person, this high level of concentration can trigger headaches and eye pain" (2111, BVI) "The robot voice for daisy books is so disappointing. Some words are said incorrectly and it requires an extra level of attention that I shouldn't need to apply." (2082, BVI)
Confidence	"It takes a lot of energy to do this, and I am not sure my contributions are useful." (2121, DHH&BVI) "People don't realise that these problems can make you feel very isolated, and it can cause a huge lack of confidence when you are trying to be like everybody else." (1840, DHH) "I did feel a little vulnerable in past wiki construction. But as we proceeded it did get better and I did reluctantly participate. The end result was better as this displayed a whole range of ideas and contributions." (1856, BVI)
Declaration of disability	"How do I let the individuals in a group know how my complex disabilities might affect me while partaking in group activities?" (2033, DHH) "if tutorials require you to take part in data reading/graphing etc I cannot access this and then have to publicly state I haven't done it as I cannot see it....I strongly dislike this!!!" (1837, BVI) "Group work is also often very difficult because I would have to divulge personal information in order to explain my access needs or why I can't do a particular task without adaptions, which is more than I want to explain to random strangers every time I have tutorial group work." (1842, BVI) "When I enquired recently about the possibility of help towards a hearing aid compatible headset, I DID NOT need to be told it wasn't a bottomless cash pot. I wasn't asking for the sake of asking. Asking in the first place is a difficult thing for me to do." (2149, BVI&DHH) "It takes me quite a long time to trust and depend on individuals as part of a group and for them to recognise my accessibility issues." (2033, DHH) "I do not wish for my disability to be plastered all around the class room or with the tutor. I much prefer to be on even playing field." (1880, BVI)

Disability awareness	“Perhaps other students should be educated how to react and assist individuals with impairment when they join in group activities, forums and tutorials. Most people want to help, they just don't know what to say or do!” (2033, DHH) “It takes me quite a long time to trust and depend on individuals as part of a group and for them to recognise my accessibility issues. Most individuals are not sure what to say or how to react for example when you notify them that you are completely deaf in one ear with limited hearing in the other. Otherwise I find group work thoroughly rewarding.” (2033, DHH)
Embarrassment	“Sometimes I hear completely different from what has been said and it can become embarrassing and confusing to all concerned.” (2033, DHH) “Being expected to speak when I struggle to hear what’s going on, having to embarrass myself by explaining I can only type, not talk as it's too challenging to try to hear what questions are being asked, take notes and reply all at once.” (2096, DHH) “I am embarrassed to join in by typing because I'm afraid that topic may have already been covered.” (1983, DHH)
Opting out	“I cannot hear them clearly enough to get any benefit from them (tutorials). I cannot, therefore join in with any discussion, or hear what other students have to say. The ones I attended were to see if I could get anything from them, and in one case because it appeared to be compulsory.” (1806, DHH) “I avoid modules where this is intense or compulsory, and I nearly backed out of a task in TU872. The tutor supported me to participate.” (2122, BVI&DHH) “No access due to deafness” (2092, BVI&DHH) “I have never attempted to attend a face-to-face tutorial because I don't believe I will be able to follow the presentation.” (2088, BVI) “I only like recordings of tutorials so I can pause, rewind, watch at my own pace since I don't always catch everything that's been said. I have not yet had to attend group activities and I'm unlikely to choose modules where I would have to.” (2049, BVI&DHH) “I won’t join an online tutorial again, far too difficult to follow” (2096, DHH)
Stress/Frustration	“When starting out with the OU it took so long to get the right tools that it was putting me off studying. was very stressful” (2042, BVI) “Audio only tutorials are really stressful. Participation is restricted because as a deaf student you are never quite sure if you have heard a question or statement clearly enough to answer” (1971, DHH)

Anxiety

The word "anxiety" was used repeatedly in survey responses. Whilst this might be a common feeling with students when considering collaborative activities, voicing opinions, and making contributions, a lot of these anxiety related responses evolved from disability related concerns such as getting alternative format materials in time, dealing with student support teams and administrative processes in order to get adjustments, as well as those related to being unable to hear or see, which were then feeding into existing anxieties. Anxieties also related directly to disabilities with concerns about other students assuming hearing/sight, and not taking their requirements into consideration during discussions or task implementations. Being online often made their disabilities more invisible and so this linked into their need for declaration of disability to groups on repeated occasions, again raising feelings of anxiety and "being a problem" for the group as a whole. Students talked about feelings of misery/depression/worry relating to not hearing in particular situations, for example where there were lots of voices, and they started to lose focus leading to further anxiety.

Concentration

The fact that intense concentration was required during online events was raised by both BVI and DHH students. They felt that it was problematic for hearing and sighted students to understand how difficult it is to participate in these sessions when a significant amount of energy and focus is needed just to be able to follow let alone fully participate. With sessions often lasting between one and two hours students talked about the exhaustion experienced from prolonged focussing on following, trying to work out what has been said, what has been shared, and keeping pace. There was mention of full flow discussions being just too fast to follow, and of focussing becoming painful and so concentration was lost. "I have to concentrate as hard on hearing as on the subject matter." (2066, DHH)

Confidence

Students talked about lacking confidence, feeling vulnerable, and of fitting in "these problems can make you feel very isolated, and it can cause a huge lack of confidence when you are trying to be like everybody else." (1840, DHH). Some felt that their contributions were not worth the energy it would take to make them and spoke of a general feeling of vulnerability.

Declaration of Disability

There were issues raised about the need to publicly declare disability to get the necessary adjustments to attend tutorials or group sessions. Sometimes this required a forced declaration during a session, or perhaps being required to explain complex needs.   Because tutorials at the Open University are held on a regional basis (referred to as "clusters"), students are in principle able to attend any tutorials within their cluster. These will be run by different tutors and not necessarily the students' tutor for the module. Their own tutor will run some of these tutorials, but it is likely that the majority will not be. Whereas it is expected that a tutor develops a relationship with their tutor group during the duration of a module, and the student can therefore communicate their needs and arrange necessary adjustments for their interactions with their personal tutors, this is not likely to be the case with other tutorials or group sessions that are not tutor led. Students talked about be made to feel "demanding" and the negotiations to attend a session making "double the work". The negotiations required to make it feasible to join in often led to students choosing to opt out owing to the excess effort required and the lack of privacy afforded to their disability status. Whilst they acknowledged that most tutors and other students were willing to help and make adjustments once they understood the situation, there was a reluctance to explain their access needs which one student expressed as "more than I want to explain to random strangers every time I have tutorial group work" (1842, BVI)

Opting Out

Perhaps the most worrying response to experiencing barriers to access, particularly for online synchronous collaborative activities, was that students were selecting to opt out of these activities rather than negotiate means to overcome barriers. There is a sense that this opting out was something the institution may not be aware of. This choosing to opt out was sometimes based on the assumptions that it was not going to be accessible, was not compulsory and therefore could be avoided. The assumptions here were generally that they either would not be able to hear and therefore follow or engage, or that they would not be able to use screen readers so cannot access any of the share materials or visual communications. Where they might have been able to overcome these barriers there was a desire to avoiding the stress of not understanding "probably not worth the stress if I can't hear or follow anything" (1923, DHH). Some students even talked about explicitly avoiding modules where group work is intense or compulsory for these reasons. There was a general assumption that these were going to be inaccessible and therefore not worth the effort or lengths required to get effective adjustments put into place. Whilst some students were unhappy with the limitations this placed on their involvement in collaborative work, others accepted it as something "not available to me" or having "no access due to deafness" (2092, DHH). This should not be the case.

Disability Awareness

A barrier encountered for students in participation was the was the lack of knowledge and experience of both staff and students in how to adapt practices and materials for accessibility. This covered materials, technologies, and general disability awareness. Staff were often not aware of how technology like hearing loops, roger pens, and screen readers work. Materials prepared for tutorials were often not accessible including unannotated images, dense text and low contrast fonts. DHH and BVI students talked about their hearing and sighted peers not knowing how to react and adjust to students with disabilities. “Students and tutor unaware of how to help e.g. speaking one at a time, facing me when talking etc.” (1905, DHH)

Embarrassment

Students talked about being embarrassed, or fear of being embarrassed during a session. Saying or hearing the wrong thing, covering or repeating what has already been said when they missed it, or being ‘spotlighted’ and unable to respond. These fears and embarrassments are not exclusive to BVI and DHH students but the probability of these situations occurring, and the student being unable to effectively respond, is increased.

There were also expressions of embarrassment at having to ask for adjustments e.g. changing seats in order to be able to follow at a face-to-face tutorial (1978, BVI&DHH), or feeling they were being an “inconvenience” (2042, BVI).

Stress/Frustration

Students talked about a build-up of stress and frustration due to the perceived barriers and “hoops to jump through” in order to participate. Stress was expressed relating to the battles required to get adjustments and access, through not being able to communicate, and with respect to audio only sessions.

Provisioning and Technical

Table 61 Technical and Provisioning Factors - Content Analysis

Theme	1. Refs	2. Positives	3. Negatives	4. Respondents	5. BVI	6. DHH	7. BVI&DHH	8. Comparison
Access to Support/Resources	66	4	35	57	43	34	13	2
Assistive Technology (General)	29	1	15	26	25	8	4	0
Complexity of Technology	3	0	2	3	2	1	0	0
Familiarity with Tech and Platform	20	0	12	16	13	10	5	2
Learning Platform (AC)	25	0	24	20	19	7	2	1
Recordings	23	10	9	21	9	15	2	1
Session Access (Online)	33	0	22	31	18	19	7	3
Speed and Pace	30	0	20	27	16	21	8	1
Technology Failure/Problems	58	0	42	53	20	36	4	6
Venue Access and Location (F2F)	62	0	48	57	32	37	12	5

Access to support, resources and venues were the most significant factors here with 66 references to Access to Support/Resources from 57 different respondents suggesting a significant problem here. These respondents came from both the BVI and DHH groups. Venue Access and Location (F2F) was also a significant concern and received lots of comments (62) mostly negative (48) from different respondents (57).

Table 62 Technical and Provisioning - Themes

Theme	Sample Quotes
Access to Support/Resources	"I am not aware of any reasonable adjustments the OU is able or willing to make. I am registered blind so need sighted guiding etc but until this year only one tutor has offered to support me with this" (1810, BVI) "The printed text books were hopeless for me to read from. Really bad. But I have learnt the art of reading the on-line versions which I can expand and really enjoy reading. Brilliant. I cannot cope with some articles that you have to download. Not all, but quite a few. The problem is that you cannot expand or even copy over into Word." (1880, BVI) "I need someone to guide me around unfamiliar places and be able to get to places and there is not always someone to take me or stay with me and am unsure if this is allowed at tutorials." (1911, BVI) "I always request early learning materials from the disability team in the form of ePub and pdf files and never get them on time and this time only pdfs which meant a lot of inaccessibility. This seems to be because the web site now provides some limited access to these types of resources but it is not enough. We still need the early access material to adapt it for accessibility. This has not happened despite repeated requests." (2040, BVI) "The software used for an entire block of one of my previous modules was completely inaccessible to me, which meant that I needed to work with a sighted assistant, whom I instructed to operate the mouse on my behalf." (2040, BVI) "I requested at the start of my course to be excused from the tutorials, as I really struggle, but I didn't feel I was really offered an alternative. I'd get a round robin email from my tutor every once in a while, and when I had an issue she was there (didn't sort it but never mind) but I did feel like I wasn't given the same support" (1812, DHH) "I do not know what is available to me as a hard-of-hearing student with degenerative hearing loss in both ears." (2087, DHH) "When starting out with the OU it took so long to get the right tools that it was putting me off studying. was very stressful"(2042, BVI) "The assistive technology does not work with the Adobe session so you need material in advance which then you don't get because there is no consistency between the OU live group and your tutor group and you have to seek permissions to contact the other tutors to get material in advance and this puts you off even trying to get involved." (2040, BVI)
Assistive Technology (General)	"I was given the Daisy reader but no one has explained how I use it and found difficult to download unit material to it so just use ebook version and use audio recorder to take notes and also online tutorials find navigation bar hard to use as cant see icons clearly enough to take part in activities." (1911, BVI) "The Daisy version does not work but I can use audible but frustrating enough the text books are not in audible format." (2052, BVI) "Occasionally PDF documents do not work with dolphin supernova. Need to try Windows magnifier then. Some images with low contrast are difficult for me to understand. Have often required alternative resources to complete task." (1977, BVI) "Using a magnifier/reader it can be extremely difficult to keep track of what is going on especially in comments or shared screens." (2058, BVI) "If the room had a loop I could hear really well using the appropriate setting on my hearing aids." (1983, DHH)

Complexity of Technology	“It's difficult listening to the tutorial, follow what students are asking, follow what's going on and listening to my assistive technology negotiating its way around” (2029, BVI) “Set up is always a problem, especially trying to join the rooms. If you are not IT aware the instructions are difficult to follow and it is easy to get chucked out of the system or have to keep trying to get into the room again.” (1910, DHH) “The technology is limited. Other students can’t adjust (ie they use systems my technology cannot access), forum posts are fast and long and take too much time to listen too, Adobe Connect Chat can be too quick to understand and reply to” (1785, BVI&DHH)
Familiarity	“when the adobe connect came out I found it confusing so my daughter helped and I found it a lot easier after the first couple of occasions” (1909, BVI) “Once I have progressed from year 1 to year 2 my confidence was built up” (1897, DHH)” “The whole navigating around and using new software takes time to get use to access and start using but takes a lot of patience and could be frustrating when a tutor has limited time” (2042, BVI) “I find using equipment fairly difficult … I feel that I’m slow working out when to speak etc. With use hopefully I’ll become more aware of this” (2133, DHH) “Just getting things in place, learning how to use them takes time and understanding. Overwhelming amount of information.” (1981, BVI) “I have visual impairment and also a hand tremor, which combine to make reading and writing very slow. I also make lots of typos. So far I am managing by setting aside longer for tasks, but I know that I don't find it easy to dictate text without planning it in writing first so ideally I would like alo be able to learn and practise that skill before I need it.” (1809, BVI)
Learning Platform (AC)	“Adobe Connect software is not very accessible with a screen reader, which makes it hard to participate promptly and fully in online tutorials.” (1948, BVI) “Adobe connect is difficult to follow so whilst using magnified or inverted screen colours.” (1977, BVI) “Adobe connect doesn’t work well with my screen reader, so I have to make do with what remaining vision I have, meaning I can’t use the chat box properly, struggle with adobe connect’s more complex functions, and have to receive the slideshows in advance in order to know what each slide is.” (1842, BVI) “I am not a huge fan of Adobe Connect. I have a couple of reasons. When I try to minimise the list of students/chat planes so I can watch the slides in full screen, the panes keep popping back up. The other thing is, I would like to be able to customise the theme of the slides e.g. white text on a black background would be far easier on my eyes than black text on a white background.” (2049, BVI&DHH)
Recordings	“I appreciate recordings this takes pressure off if I miss a point or get knocked off internet. I can also go over parts of tutorial that I was not able to keep up with especially chat box comments when lots of people take part and I have large font so can’t see” (1856, BVI) “Generally, I prefer to view recordings, and I can work through the tutorial at my own pace.” (1903, BVI) “It's easier for me to sometimes be able to play back tutorials if I didn't hear what the tutor was saying the first time around.” (1830, DHH) “I only like recordings of tutorials so I can pause, rewind, watch at my own pace since I don't always catch everything that's been said. I have not yet had to attend group activities and I'm unlikely to choose modules where I would have to.” (2049, BVI&DHH)

Session Access (Online)	"For my disability I was not given clear instructions how to get to watch the tutorial, which meant I missed it. I was given a link to take me to the site then I was asked to put an address in and I wasn't given one to put in. I got really confused as to what to do" (2064, BVI&DHH) "I attempted to access the wrong room and was in the group room not the tutorial room. My fault but it seems an easy mistake to make" (2090, BVI) "Didn't realise I had to choose from a list of tutors and rooms. Was taken to room at top of list which was not being used and found myself in waiting area! nothing to tell me I was in wrong room so wasted a lot of time exiting and re-entering same wrong room. Not the only person to have done this - seems to be quite common." (2125, BVI)
Speed and Pace	"I can not always follow the board... if tutor moves too fast." (1823, BVI&DHH) "forum posts are fast and long and take too much time to listen to" (1785, BVI&DHH) "Sometimes online tutorials happen very quickly. By the time I have heard and processed the question other students have already answered it and this is often disheartening." (1827, DHH) "I do attend where ever possible but it is never easy keeping up & I miss most of what other students say" (2149, BVI&DHH) "working out how everything works so it is easy to miss what the tutor says" (2042, BVI) "Online tutorials can proceed at a quick pace. if you are disabled as I am with slow processing skills it is very easy to get behind." (1910, DHH) "With my hearing difficulties I find it hard to keep up with live tutorials and find myself getting lost as to what is going on" (2108, DHH)
Technology Failure/Problems	"Online Room does not always open on time or loss of connection occurs at some point during the lecture. Sound can be muffled or incoherent at times." (1943, BVI) "online tutorials. even with decent headphones are difficult as I have to remove my hearing aids" (1979, DHH)" "Set up is always a problem, especially trying to join the rooms. If you are not IT aware the instructions are difficult to follow and it is easy to get chucked out of the system or have to keep trying to get into the room again." (1910, DHH) "I got to the site but couldn't join in. This is probably because I was fairly new to computer work. It was some years ago. I think I could hear but could not take part." (1912, BVI) "I was unable to connect the microphone so couldn't speak in the group. I am currently getting to grips with the OU website visually" (1934, BVI) "Occasional issues with access or getting sound once in room. On occasions, coming out and re-entering solves it, on other occasions using a different browser works." (1779, DHH)
Venue Access and Location (F2F)	"Being visually impaired and the location of the centres near to me means I am reliant upon others to take me to the tutorials but apart from that, I find them really informative, helpful and enjoyable." (2151, BVI&DHH) "The travelling distance to face-to-face tutorials makes them inaccessible to me. As I have low vision, I cannot drive." (2102, BVI) "This is a difficult one! my last face-to-face was a 4 plus hour round trip. Normally I would sit in front of tutor but the only place to sit was at the far side of where the tutor was set up. Although I informed him I was hard of hearing the majority of time he was facing away from me looking down reading from computer which was facing a wall so I found it difficult to hear or see his face to lip read. I

	understand that the setup of the room/computer was out of his control but it was very frustrating and I felt as though time would have been better spent staying at home studying." (2130, DHH) "I find the locations and venue for the exams appalling, these days, in terms of lighting for people with some degree of poorer vision - in my personal experience. They are never bright enough, have poor level of artificial lighting and there is no way to boost the lighting. You cannot even decide where you sit to maximise lighting levels." (1900, BVI) "I need someone to guide me around unfamiliar places and be able to get to places and there is not always someone to take me or stay with me and am unsure if this is allowed at tutorials." (1911, BVI) "I tend to avoid face-to-face tutorials because of needing support to get to and from the venue, plus the time involved in travelling." (1965, BVI&DHH)

Access to Support/Resources

Comments regarding access to support and resources ranged from those unaware of support available "I am not aware of any reasonable adjustments the OU is able or willing to make" (2029, BVI), to frustrations and complaints about the complexity and lack of transparency in the process to gain access to support. A significant proportion of these frustrations related to the provision of alternative format materials. These were often late, badly printed or with missing components, or less accessible that had been expected. "Two years in succession failed to deliver my alternative format material before the course start date. Still waiting for this year's. First TMA[16] due in the week after next." (1832, BVI). Whilst access to alternative materials caused the most frustrations there was also a feeling that they were not being equally provided for, that there was a need for support that was not being met, and that there were problems and frustrations resulting from having to repeatedly ask for support or resources.

Complexity of Technology

Students talked about the complexity of dealing with technology. These included general problems with different devices, software, and accessories and those relating to assistive technologies including screen readers, voice to text, and configurations/technology compatibility issues. Whilst some of these technological complexities present barriers for all students the adding of assistive technologies to the mix presented some additional barriers.

Different devices had different capabilities and students talked about having to switch between devices, for example using the screen reader on a mobile device whilst participating in an online session on a laptop or desktop computer. The problems of managing sound from a screen reader simultaneously with voice communications was highlighted, juggling between screen reading and listening to speakers. Configuring programs and platforms to suit individual needs such as volume control, screen colours/fonts/contrast as well as getting microphones and webcams working effectively were all raised as problematic. There was also frustration about the need to re-configure settings for each session rather than being able to maintain and control personal setting choices between sessions. The complexity of integrating all the different aspects of online learning was also raised: live tutorials, online materials, recordings, software and activities.

[16] TMA – Tutor Marked Assignment

Assistive Technology (General)

General problems relating to assistive technologies (AT) included being given technology but no training in how to use it, the incompatibility of Adobe Connect with AT, and conflicting/inconsistencies with technologies in use.

In a face-to-face setting there were problems with room setups and equipment (generally related to use of a hearing loop, or a roger pen). The OU, as a distance institution, often holds tutorials or day school at other academic institutions or alternative venues. Therefore, as face-to-face locations are often not familiar to either the students or the tutor this was more frequently a problem than it might have been in traditional, familiar locations.

Familiarity with Tech and Platform

Several students expressed the need to have time to get familiar with technology, and time to set it up. Becoming familiar with the way the learning platform and module sites worked seemed to link with increased confidence and technical awareness. Some problems with technology are perhaps lessened with time and experience. In terms of assistive technology, for those students new to using products this can be a steep learning curve and when starting studying can contribute to the pressure a student experiences.

As well as feedback about familiarity with the platform and assistive technologies, students raised the need to have familiarity with layouts, with other students, and with tutors. Familiarity reduced the barriers.

Learning Platform (Adobe Connect)

Although mostly outside of the scope of this research there was a great deal of comment around the use of Adobe Connect as the designated platform for tutorials and group work. There was concern about the general robustness of the platform, with students reporting regular problems with access, being ejected from rooms, losing sound and internet connections, and the general unreliability of the platform. Whilst it is not possible to evaluate what proportion of these issues were as a result of student equipment and/or broadband issues, there were consistencies in the connectivity problems which suggested it was more related to hosting/provisioning than student-side matters. What did become clear was that certain required features were not available in the platform, and some of the methods and practices of using the platform were causing barriers. Required features missing from the learning platform included the ability to screen read all platform content and to adjust the panels/pods within the platform. In terms of methods and practices, those causing barriers included requiring live captioning to be external to the learning platform (Adobe Connect), changing screen layouts during a session and when placing students into breakout rooms for group activities, and the default practice of not using webcams (although this may also be connected to the unreliability and network connectivity issues). Other usage practices that caused access problems (particularly with screen readers) were popup broadcast messages (interrupting screen reading and difficult to remove), polls, icons and emojis that were either difficult to identify with poor vision, or not screen readable.

Recordings

Although not essentially related to collaborative learning, there were many students who emphasised the importance of recordings of tutorials and group sessions being made available. This enabled students who were unable or unwilling to attend live sessions to have access to the content so were often used as an alternative to attending. This was frequently linked with the barriers presented with following live tutorials and the pace and concentration required to do so. Students talked about using recordings to pick up on missed sections of tutorials and, through repeatedly pausing and re-watching, being able to make sense of communications that they had or would have missed during a live session. This caused less strain on communications, avoided pace and 'keeping up' issues and was seen as a viable substitute by some. Others highlighted the fact that this provided a substitute but not good or equivalent alternative as they were not able to participate.

The absence of transcripts and captioning on recordings of live tutorials and group work was also highlighted. Whilst these were available for module content and materials, this was not generally the case for tutorial recordings. This made the recordings still inaccessible to some students.

Session Access (Online)

Some students were missing tutorials and arranged group sessions as they were encountering problems finding the online rooms and links or invoking the software in order to join the session. Finding the link to the room or recordings from website required a fair amount of navigation from the student home page and with multiple rooms available and being used for different sessions, students sometimes ended up in the wrong room and were not able to recognise that this had happened. Whilst this might be the case for all students there are more visual cues to enable students with vision to assess this error such as presenters or tutors not being present or no slides being shown. There was mention of sessions not always being on their study calendar or needing access via different routes than those they were familiar with. Again, some of this was accreditable to the organisation structure of student modules with different rooms for module-wide, cluster and tutor group sessions. Having navigated to a session there were reports of software problems, such as Adobe Connect needing updates, and then on re-install the path to the session had been lost so needing to be re-navigated. During these processes there were also references to losing screen reader focus or screen navigation becoming difficult.

Speed and Pace

Speed and pace of sessions was a major barrier for students from both target groups. Sensory impairment entails relying on alternative means of communication, and seeing/reading and hearing/listening processes with limited sight or hearing means that the processing of those communications takes longer. In a moderate or fast paced session this means that the students are not given the opportunity to engage with the conversation. By the time the communications have been consumed and processed the conversation has moved on. Students talked about trying to keep up when parts of the conversation are missed, and 'tuning out' when the load becomes too much. There were also generalised comments about the pace of learning within a module with talk about pressure from forums which often have students further ahead than themselves. Whilst this was not generally related to sensory impairment it increased the pressure on the students.

Technology Failure/Problems

General technology failure and problems arose from loss of connection, poor quality of sound and problems navigating to or accessing the rooms. Getting microphones and cameras to work and losing synchronisation with the communications all become more significant issues when the processes to resolve them or navigate them become more complex because of sensory disabilities.

Venue Access and Location (F2F)

Although face-to-face tutorials were the preference for most students these were not without problems and most of these related to venue access and location. As a predominantly distance-based study university when tutorials, workshops and day schools were organised these were often at non-OU locations. These could be some significant distance from the student and would be unknown territory. For DHH and particularly BVI student this involved several unknowns, such as support staff to direct them to the appropriate locations, unfamiliar classrooms to physically navigate, and no on-site staff or infrastructure to help either the student or tutor resolve potential accessibility issues.

As the locations were often distant from the students' residencies there was also a problem with travel and dependency on others to access/travel to the venue. Additionally, as mentioned, facilities could be problematic: hearing loops, lighting, projections, and big echoey rooms. "In a big room the tutor's voice was barely heard and in dim light I was struggling to see what she was saying and when I was trying to lip read I was missing out info on slideshow. It was very tiring and upsetting." (1921, DHH)

Activity and Session Design

Content Analysis

Table 63 Activity and Session Design Factors - Content Analysis

Theme	1. Refs	2. Positives	3. Negatives	4. Respondents	5. BVI	6. DHH	7. BVI&DHH	8. Comparison
Activity Design	13	1	11	11	11	1	0	1
Dissemination of Information	2	1	0	2		1	0	1
Group Size	12	0	5	12	2	8	0	2
Shared Materials	18	2	8	17	10	11	4	1
Text Size/Colour	23	0	17	20	23	6	6	0
Tutor Response and Awareness	55	12	24	45	19	34	4	6
Tutor Understanding of Accessibility	16	3	8	16	9	11	4	0

Tutor response and awareness of students' needs was the most referenced theme in this category with 55 references from 45 different respondents, and a mix of BVI and DHH students.

Table 64 Activity and Session Design - Themes

Theme	Sample Quotes
Activity Design	(problems with) "Using OSL and seeing detail. Seeing microscope images, with low colour contrast Differentiating between colours in diagrams and images" (1997, BVI) "Just eyestrain when trying to work with mathematic formulas. E.g. I have my Adobe Acrobat Reader set to display coursework pds with a dark background and light text, unfortunately, formulas don't always display properly when I do this so I have to flip the settings back and forth. I don't like the textbooks at all because the pages are slightly shiny and are difficult to read." (2049, BVI&DHH) "It is my worry for the future as some of my assignments are group based that I will not be able to participate as I do not have the necessary adaptions to hear properly online," (1834, DHH) "I cannot use electronic microscopes as my vision is restricted to various parts of my eyesight and rely on other students to describe what is present on any slide rather than find out for myself." (1943, BVI)
Dissemination of Information	"Tutors should be aware of students with learning difficulties rather than them having to tell every tutor." "When the tutor is proficient and when attendee students set everything up properly things go well. Took me a while to learn to cope. Typically, some sessions were better than others. Those tutors that helped students by providing intro emails including what was needed and the topics, ensured all went well." (1783)
Group Size	"I find it easier when only a few people attend. I can follow what is being said" (2141, DHH) "When groups are too large, some students voices get lost." (2120, DHH) "would be good to have more informal sessions also outside of the tutorials. Perhaps groups of no more than 4 students encouraged to join non tutorial groups but within their module?" (1967, BVI) "I am about to start another one where the tutor group are divided into smaller groups and not whole tutor group. I hope this will be better." (2069, DHH) "Large group, lecture theatre tiered rows pose problems for me even with my kit in use" (1905, DHH) (Forums/wikis) "In large tutor groups (I am currently in one of 28), if everybody was regularly contributing, then I feel it can become a lot of posts to keep up, and too time-consuming to read them all. But I must say, having them there as a saved reference point is very useful for later reference." (2025, BVI) "So far the only groupwork has been by Wikis and a Forum. The latter being course wide and involved so many participants it was difficult to progress an idea or observation." (1971, DHH)
Shared Materials	"All online resources require alteration, ICMAs[17], practice activities. All books need adaptation even if they are already electronic. Daisy books do not exist for beginners Spanish and Italian, the French beginner ones require review and alteration as they are read exactly as the book has the content but this is better altered for the blind as the text is cumbersome otherwise and hard to navigate as a result. Books should be reviewed and accredited by the access team in same way as they are accredited by the module subject matter experts." (1967, BVI) "On F2F tutorials it is rare that I can see material prepared by the tutor when it is shown on a screen." (1935, BVI&DHH) "If charts or images could be sent out in advance you are then able to view and understand the information before it goes on display and to follow the talk on as it proceeds." (1910, DHH)

[17] Interactive Computer-Marked Assignment

	“have to receive the slideshows in advance in order to know what each slide is.” (1842, BVI)
Text/Font	“screen reading is a problem when it is 'fixed' and cannot be size adjusted properly, only blurry. Especially true of graphs, subscript/superscript. Font used is sometimes difficult to tell the difference between letters/numbers. Also, at the end a day, my vision can mean I cannot see anything properly- paper or screen and wish more talking book versions were available” (1837, BVI) “Although I get the module work sent to me in large print anything else is small online and if you make it big enough to read it takes forever to go through it all.” (1826, BVI & DHH) “I need the text enlarged but then i can only see a couple of words without scrolling back.” (2054, BVI) “The software used had no option of a larger font size and I find that onscreen magnifiers make me motion sick. I could not join in text-based activities.” (1908, BVI) “I have to always adjust the chat text size everytime I go into a tutorial as it doesn't remember my preferences” (2091, BVI)
Tutor Response and Awareness	“Several times tutors don't seem to know how to use the software their end. Turning mics off, no volume , most distracting.” (1906, DHH)
Tutor understanding of accessibility	“Tutors would benefit from some training in how to deliver when there are students with hearing impairments in the room. My recent tutor was very good content wise by was a low, quiet speaker who didn't always face forward, moved around while speaking and his tone faded off at the end of sentences so very difficult to follow.” (2021, DHH)

Activity Design

Some collaborative activities were not accessible to BVI/DHH students, such as field work and practical science work “colour blindness made some challenges impossible in particular virtual microscope and rock formation differences.” (1856, BVI), “I find tools such as drawing too difficult for instance we needed to mark a map of the UK to say where we are from however, I know where my area was but I was unable to see it on the map and could not negotiate the pen” (1856, BVI). Sometimes the activities required more time than was available for the student to complete. When whiteboards were shared in order for the students to exchange ideas these were often not available to BVI students so they were unable to participate.

Dissemination of Information

Dissemination of information, particularly with regards to reasonable adjustments and specific student needs, within the institution and between sessions was seen as a significant barrier. When students were able to feel supported and their tutors for a session were aware of their needs, there were generally better experiences. There were varying experiences of failure of dissemination of information, but also good experiences of tutors responding to students’ needs and passing on both good practice and useful understanding of where students might experience problems. Dissemination of information regarding possible support and adjustments available was perceived as poor with some students unaware of possible assistance they could access.

Group Size

Large group size caused barriers for some BVI/DHH students in collaborative sessions with students mentioning how it is easier to identify other students in small groups, to identify who is speaking, and how small groups limited the number of different voices that they needed to adjust to. Small group size allowed students to gain familiarity with both environment and peers, and this helped build confidence to participate.

Shared Materials

Utilising accessible shared materials was raised as an issue with students from both the BVI and DHH groups. This included materials shared during the process of a tutorial or as material for group work as well as tutorial slides and supplementary module material. For synchronous sessions using shared materials, such as PowerPoint slides or exercise/activity instructions, students talked about needing slides in advance of a session in order to be able to join in with everyone. This enabled them to consume the slides in advance in whatever manner they chose so that they were better prepared for a session. This might mean electronic or printed materials in different formats/sizes. Most importantly these had to be accessible materials, so ones that could be read with screen readers, navigated by keyboard, and generally conformed to accessibility standards.

Text/Font

The size of text and related font attributes was a common theme both in relation to captioning, chat panes and transcriptions, and in shared materials and on-screen content. Magnifier users talked about enlarged font and the problems of having little text available on screen at any one time, at face-to-face sessions the size and clarity of projected/shared written content, the size of text boxes for data entry, chat boxes, graphs, and use of super/sub text and formulae were all problematic, particularly for BVI students. The size of chat makes it difficult to contribute, keeping up on shared group tasks and it can be a slow progress consuming content when only a few words are shown at a time. Students talked about the strain of spending too much screen time having an impact on their ability to see or needing to continually, and repeatedly, adjust font size. There were also comments about the fixed caption size/colour on video content, and the necessity to be able to adjust font and background colours to their preferred colour combinations.

Tutor Response and Awareness

Students had varied experiences of tutors, their level of response, and their awareness of how to teach and design sessions and activities in an inclusive way. Most students indicated that tutors were willing to make adjustments when asked but were not generally aware of how to do this and it generally fell to the student to ask for adjustments rather than be offered them. Many tutors were not aware of students' disability statements or accessibility needs until informed. The general process then seemed to be a negotiation between the student and tutor as to how to address their needs.

Tutor Understanding of Accessibility

In parallel with the tutor response and awareness was the theme of tutor understanding of accessibility. Many students felt that tutors did not have the necessary training or experience to incorporate accessibility into their teaching and materials. This included tutors having no concepts of assistive technology or how they worked, being unaware that students were using assistive technologies (such as screen readers and voice to text software) in their sessions, and simply not knowing either what facilities were available for their students or how they could adapt their practices for greater accessibility. Students in general felt that accessibility was not prioritised, that their need became 'problems' for the tutors, or the adjustments they required were unfair to other students. This seems to stem from a lack of a cohesive approach to accessibility.

P1S1 Thematic Analysis General Comments

Thematic analysis revealed that there are substantial barriers presented to students when collaborating. Many of these barriers are specific to BVI and/or DHH students (e.g. use of screen readers and/or magnification), but those that are applicable to the student population in general (such as confidence or familiarity) were exacerbated because of the disability making engagement, and therefore collaboration, significantly harder.

5.3.2 Online/F2F and Synchronous/Asynchronous

One of the hypotheses for this research was that online synchronous collaborative activities provided more barriers to BVI/DHH students than other formats. For this reason, a comparison of learning environments – synchronous and asynchronous, online and face to face was included in the survey and the results are discussed here. A separate coding process was implemented using the codes online, face-to-face, forums, wikis, and group work. This section reports on the content and thematic analysis of these five areas. As with thematic analysis in the last section relevant text was coded under these categories and categorised as a positive or negative response where appropriate. Statistical analysis of the quantitative data was triangulated with the content and thematic analysis of the qualitative data from the survey. The content analysis is provided in table below.

Table 65 Learning Environments - Content Analysis

	1. Refs	**2. Positives**	**3. Negatives**	**4. Respondents**	**5.BVI**	**6.DHH**	**7.BVI&DHH**	**8.Comparison**
Online	22	14	5	20	11	9		2
Face-to-face	79	61	9	69	33	54	14	6
Forums	48	6	26	47	19	32	7	4
Wikis	22	5	17	22	8	14	1	1
Group Work	74	13	49	62	24	50	7	7

Face-to-face tutorials elicited the most responses with 79 references from 69 respondents which were predominantly positive.

Codes which related to learning environments (LE) were cross referenced with the categories and themes emerging from the thematic analysis to highlight any cross tabulation “hot spots”.

Table 66 Learning Environments Cross References to Themes - Content Analysis

Theme	Online	Face-to-face	Forums	Wikis	Group	Total	LE Only	Percentage themed
No Theme	12	43	40	15	46	585	305	
Access to Support/Resources	2	3	0	0	2	68	59	13.24%
Activity Design	0	1	0	0	0	13	12	7.69%
Anxiety	0	1	0	0	1	16	14	12.50%
Assistive Technology (General)	0	0	0	0	0	29	29	0.00%
Complexity of Technology	0	0	0	0	0	3	3	0.00%
Concentration	0	2	0	0	0	9	6	33.33%
Confidence	0	1	0	1	2	19	15	21.05%
Declaration of Disability	0	1	0	0	2	10	5	50.00%
Disability Awareness	0	0	0	0	1	3	1	66.67%
Dissemination of Information	0	0	0	0	0	2	2	0.00%
Embarrassment	0	0	0	0	0	6	6	0.00%
Learning Platform (AC)	0	0	0	0	1	25	23	8.00%
Lip Reading	0	2	0	0	0	10	8	20.00%
Navigating Screen	0	0	3	0	0	24	21	12.50%
Online Chat	0	0	0	0	1	6	5	16.67%
Opting Out	0	2	0	0	1	45	42	6.67%
Technology Failure/Problems	0	0	0	0	0	58	58	0.00%
Recordings	0	1	0	0	0	23	22	4.35%
Screen Reading	0	0	1	1	1	20	17	15.00%
Session Access (Online)	1	1	0	0	1	34	31	8.82%
Venue Access and Location (F2F)	2	14	0	0	0	63	46	26.98%
Familiarity with Tech and Platform	0	0	0	0	0	20	20	0.00%
Shared Materials	0	0	0	0	1	18	17	5.56%
Speed and Pace	1	2	1	0	2	30	24	20.00%
Stress/Frustration	0	2	1	1	1	14	9	35.71%
Text Size/Colour	0	0	0	0	0	23	23	0.00%
Transcripts and Captions	1	1	0	0	0	31	29	6.45%
Tutor Response and Awareness	2	5	1	0	2	57	46	19.30%
Tutor Understanding of Accessibility	0	1	0	0	0	16	14	12.50%
Unable to Follow/Join In/Participate	0	2	1	0	3	37	31	16.22%
Unable to Hear	0	1	0	0	0	45	44	2.22%
Seeing People	0	1	0	0	0	11	10	9.09%
Group Size	1	1	1	0	0	12	9	25.00%
Sound problems	1	4	0	0	0	69	64	7.25%
Group Interactions	0	2	1	5	13	34	13	61.76%

Cross referencing the themed references with those coded for each of the learning environments showed a distinction between the two forms of coding with the majority just coded for Learning Environment. The only themes with a significant percentage overlap, other than those with too small a quantity to infer significance, was Venue Access and Location, which was a code closely related to the format (face-to-face) so this was predictable. Interestingly Stress/Frustration was distributed across different learning environments but again the sample was too small to infer any significance.

Table 67 Learning Environments - Codes

Learning Environment	Format	Sample quotes
Synchronous	Online	"I love working online because I find the concept of attending a meeting remotely really accessible. I don't need to worry about getting to or navigating an unfamiliar location. I can save time. I don't have to worry about transport." (1780, BVI) "I like the independent learning of the OU (I've finally found a style of learning that works for me) and online tutorials allow you to have that better than face-to-face." (1877, BVI) "I am doing distance learning because I want the whole experience to be online. I know some students prefer face-to-face tutorials, but I would rather have accessible online ones." (1780, BVI)
Synchronous	Face-to-face	"They are far and away the best way for a hard of hearing person to follow what is going on. Plus the interaction generally is much greater and properly nuanced, which does not happen online." (2066, DHH) "The main problem I have with online tutorials is that I lipread and due to my dyspraxia I find it hard to quickly type in my responses so feel that I am more of the audience rather than the participant. However with face 2 face tutorials all these barriers are overcome and I get a lot more from the session" (1915, DHH) "Online tutorials cannot take the place of Face to Face sessions. It does not work. They are good at giving a different perspective, and as a back up. but F2F are invaluable." (1937, BVI&DHH) "There can be no substitution for a deaf person, he/she needs to lip read. So seeing the tutor is essential for fuller participation and actually receiving the information. There are still areas where words or understanding is lost, but it is easier to realise this with a visual connection" (1971, DHH) "Being visually impaired and the location of the centres near to me means I am reliant upon others to take me to the tutorials but apart from that, I find them really informative, helpful and enjoyable." (2151, BVI&DHH) "Worse than online tutorials for someone with hearing impairment as laughter, nervous laughter, eating snacks etc. all are an obstacle to hearing what is being said. However the best for learning." (1779, DHH)
Asynchronous	Forums	"I find forums can be useful but I also think they can make you feel pressured into working faster than necessary." (1816, DHH) "I've made good friends through the forums, we've helped each other through stressful times and I wouldn't have felt as motivated to push through those stressful times without them." (1877, BVI)

		"I think most forum exchanges are a waste of time but occasionally something of interest does come up. However, time taken to trawl through is precious and lost." (1935, BVI&DHH) "Forums are always useful but unfortunately there can be individuals who dominate the threads and who can act in ways that are perceived as bullying and insensitive. I have experienced a module forum where the vast majority of us just gave up because of the behaviour of one individual." (2015) "If you get an engaged group who are raising relevant questions on the study materials it can really be helpful in advancing your understanding and thinking around the subject." (2017)
Asynchronous	Wiki	"Wikis. I am just wondering if they really are good educational learning experience as they are time consuming and involving too many that wait for others to do all the real work. I realise you know who does all the work... but it is unfair on others not to benefit from that missing contributor's knowledge." (1880, BVI)

Online and Face-to-Face

"The human engagement with both tutors and fellow students is really important for all students. As is sharing the academic journey" (1971, DHH)

There was an overall preference for face-to-face learning events rather than online. This was particularly the case for DHH students. Less so for some BVI students. Where preference was for online this was predominantly linked with the choice of a distance education establishment and fitting study around work and other commitments.

In terms of the learning experience at face-to-face sessions DHH students showed a marked preference, commenting on the importance of seeing faces, being able to lip read, communicate and make connections with greater ease than in the online session. "I can sit close to the speaker, wear my aid, read lips and ask them to clarify anything I miss" (1919, DHH)

Disclosure of disability was perceived by both study groups as easier in a face-to-face session, with students able to liaise directly and privately with a tutor to explain their needs, to physically position themselves to be able to lip read or see the screen. Students used words including enjoyment, satisfaction, engaging, fun, helpful, motivating, pleasurable and rewarding. They talked about making connections, having fun and it being a generally positive experience.

Making connections with tutors and other students in a face-to-face context also enabled better experiences of subsequent online learning events "Face-to-face tutorials are important as it is easier to lip read and ask questions about what has been said. It also makes future online tutorials a bit easier, as you know the people." (2056, DHH)

Negative responses were around background noise and venue facilities as well as tutor understanding of how to make a session accessible. The lack of hearing loops, bad lighting and echoing rooms were all cited as negative responses to face-to-face learning events.

Across all respondent groups (hearing/DHH/sighted/BVI) there was a positive response to face-to-face tutorials. There were negative responses in relation to the location of tutorials and day schools and access to venues.

"They are far more informative, dynamic and meeting fellow students can lead to friendships and invaluable peer support. Tutors are invariably more engaging face to face and interactions between all parties is more natural and rewarding." (2019, BVI)

Key points are that, particularly for DHH students, face-to-face enables better communication and a feeling of belonging as well as establishing relationships and contacts with other students which are often maintained after the event “It builds for better relationships with the tutor and other students” (1915, DHH). For BVI students there was a feeling of better control and reduced anxiety when attending online as they were able to control their environment better. “I love working online because I find the concept of attending a meeting remotely really accessible. I don't need to worry about getting to or navigating an unfamiliar location. I can save time. I don't have to worry about transport.” (1780, BVI). Navigating unknown venues and negotiating adjustments was more complex in a face-to-face situation.

Familiarity with venue, technology, people and materials were all highlighted as factors influencing their choice and preference for online or face-to-face.

Asynchronous Online

Group work often takes place on forums and wikis as either assessed or non-assessed components of the module. Whilst forums are available on all modules for various different topics, wikis tend to be module specific and more likely to be assessed. As such, all students were familiar with forums but some were unfamiliar with wikis which had a lower response count.

Tutor moderators had an impact on students’ engagement with forums “So much depends on the moderator. We had one forum which was an excellent experience - but that was down to the moderator. He was active, supportive, and approachable. It made all the difference.” (1792). Structure was also raised with comments such as “haphazard” (1936, DHH)

Negative feelings arose from a number of students where they felt left behind or undermined by other students comments in the forums. “Some forums have left me feeling unsure of what I am doing on some courses as contributors seem to be more advanced in their knowledge of the subject matter and come across as 'talking down' to other contributors” (1943, BVI)

BVI students were more likely to experience problems with forum collaborative work, and much of these related to the time taken to consume and navigate forums using screen readers. “I dislike having to use forums for assessment. I prefer to learn what I need to and collate data from students when necessary, but forums are a time consuming nightmare when I have very little time for literally no benefit!” (1837, BVI). Some students were unable to participate because of simple barriers “The forum submit button is not accessible to my screen reader. It is not announced correctly nor consistently most of the time.” (1967, BVI)

There was evidence that some students found the collaborative process spilling over into social presence “I've made good friends through the forums, we've helped each other through stressful times and I wouldn't have felt as motivated to push through those stressful times without them.”

(1877, BVI). Others saw them as an unimportant part of the academic requirements “A valuable resource if one desires to exchange ideas or seek support from fellow students. Otherwise, of little purpose to me personally.” (1890, BVI)

Exchanging ideas and getting responses from other students, tutor and moderators was seen as a positive process “I find forums useful and do participate in them, probably not as much as some of the other students but reading other people's queries and the answers from tutors/moderator is very helpful to me.” (1895, DHH), others found them a “distraction” (1929, DHH). Some had mixed feelings “I think most forum exchanges are a waste of time but occasionally something of interest does come up. However, time taken to trawl through is precious and lost.” (1935, BVI+DHH)

5.3.3 Areas identified for more research from P1S1

P1S1 of the research highlighted a number of areas that warranted further research and expansion. These areas included:

The use of assistive technology in collaborative work: with multiple mentions of use of screen readers, magnification software and voice to text, the use of assistive technology and the impact this has both positively and negatively on the ability to collaborate was an area that needed clarifying and deeper investigation.

The use of interpreters: there was mention but little discussion on the use of interpreters, captioners, and non-medical helpers when attending sessions. These were services that could be provided at the OU, and I was aware of their use by some students, but there were very few mentions of this from the survey. No questions directly addressed this so this was a potential missing area from the survey that needed to be filled.

Captioning and Transcription: these were areas of frustration expressed by many students so it was important to understand the nature of these frustrations, what services were needed, what positive and negative experiences students had encountered, and how the use of captioning and transcription could be best implemented for maximum effectiveness.

From the staff perspective it was important to explore the issues that arose in terms of provisioning, materials, and staff awareness and training.

Designing/implementation of accessible materials, activities and environments: Frustrations arose when activities and materials were not accessible so it was necessary to consider what accessibility criteria were being applied to shared resources, what controls were placed on the production of materials and activities, and how the learning environment could and should be optimised for inclusivity and accessibility.

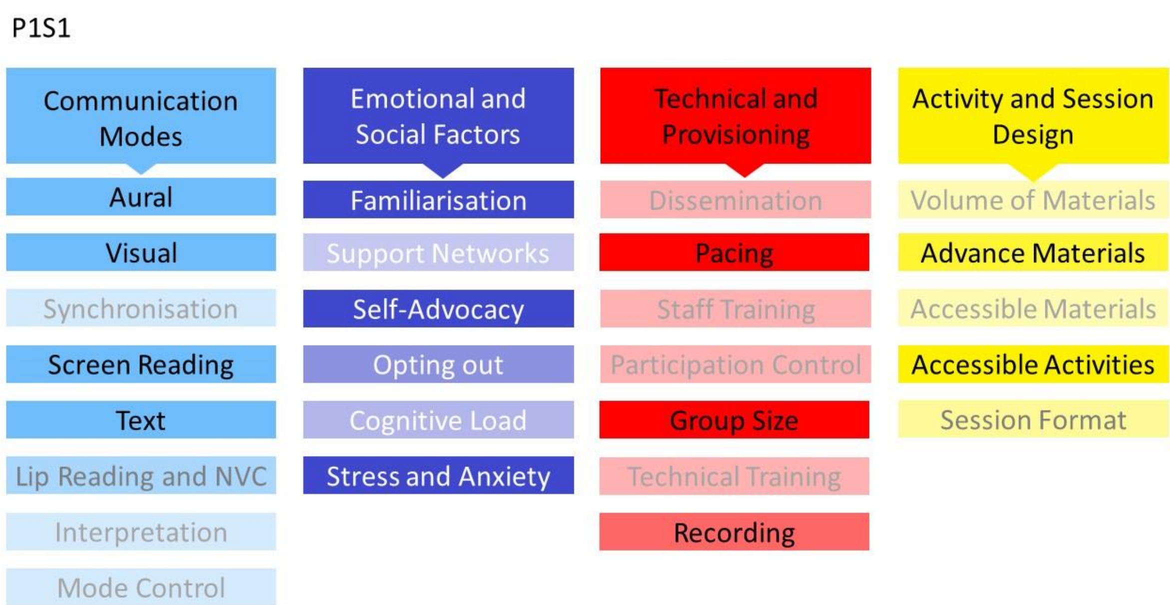
Staff training and awareness of working with students with disabilities: Whilst staff were often perceived as willing to help their understanding of how to do so was often limited.

Processes and provisioning for reasonable adjustments: students were either unaware of, or frustrated with, the processes and provisioning for reasonable adjustments so clarity on the services available and the processes for implementing them was required.

5.3.4 Retrospective Mapping to Model

The four categories and 36 themes were retrospectively mapped onto the final model to see how the codes and themes had developed during the analysis process, and to cross check the body of evidence behind each component. This also allowed a retrospective analysis of the validity and strength of the findings. The P1S1 mapping of the codes to the model is illustrated below and the changes and re-mapping of these themes is covered in subsequent iterations. This diagram illustrates the status of the final model as viewed from the end of P1S1. The strength of each theme at this stage is represented in terms of transparency, so those themes with a high level of transparency are ones that emerged from later stages of the research whereas those with lower levels of transparency emerged predominantly from this phase of the research. The level of transparency represents the body of evidence at this point.

Figure 13 - Mapping to Model - P1S1



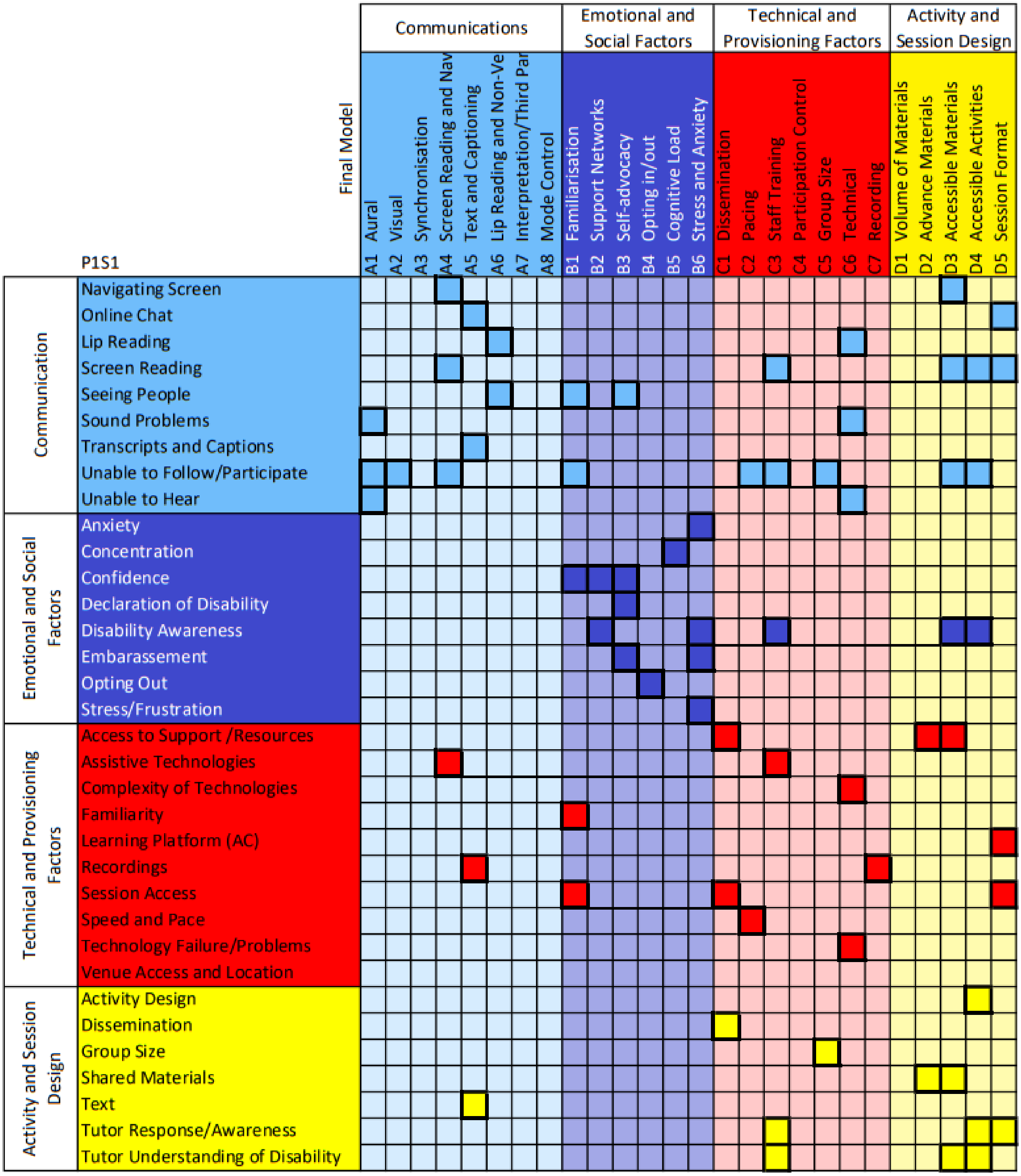
5.3.5 Model at end of P1S1

The matrix diagram in Figure 14 shows how the themes from P1S1 mapped to the final themes with some changing categories as the reflective and iterative process identified new themes and restructured existing ones.

The categories and codes from P1S1 are listed on the left with the final model categories and themes along the top. During the re-coding process at the end of each thematic analysis some content moved from one theme to another as the themes developed so the highlighted squares indicate where coded items from the original themes were finally placed.

For example, survey responses categorised under Navigating Screen were mostly mapped to A4 (Screen Reading and Navigation), but as some related to the problems with the accessibility of the materials these were remapped to D3 (Accessible Materials).

Figure 14 Mapping of P1S1 Themes to Model



5.3.6 Summary – Survey (P1S1)

The survey was designed to address RQ2 and identify barriers to engagement for students with sensory impairments in collaborative learning. A second aim of this survey was to understand how the students managed and dealt with these barriers and their suggestions as to how these barriers might be reduced. There were clear barriers identified in the survey data and indicators in some instances of where the problems needed to be addressed.

In comparing Hearing/DHH and Sighted/BVI responses it was possible to establish that respondents with sensory impairments were indeed experiencing barriers to engagement in collaborative learning.

The survey produced a broad perspective on barriers to collaboration and engagement in general, but also confirmed that that there were barriers that were specific or exacerbated for DHH/BVI students, and that the specific combination of synchronous and online collaborative sessions raised the most obstacles for these students (particularly DHH students).

The barriers identified in the survey (as represented in Table 55 Categories and Codes) are summarised as follows: In synchronous online tutorials students identified problems with following the tutorials, generally because of the barriers presented by reliance on aural communications as the main source of conversation. This meant that they were unable to contribute/collaborate and were often choosing to withdraw, opt out, or watch recordings rather than attend which resulted in them taking a passive observational role and prohibited collaboration. Additional problems arose with shared resources that were not screen readable, and problems with screen reading the environment in general (popups barring access, chat panes difficult to navigate, screen areas difficult to identify or navigate) for BVI students.

For DHH students the absence of visual cues to make meaning in an online environment provided a major obstacle (being unable to read lips or body language). This was contrasted with their experience in face-to-face sessions where negotiating adjustments was easier.

The speed and pacing of sessions proved a barrier to participation too with a lack of thinking and processing time, the complexities of interpreting communications taking longer to digest because of 'making meaning' from limited sound or switching between transcript reading and/or interpreters. Students who used magnification software or screen readers found that identifying areas of focus took time. With each of these delays opportunities to engage or contribute were limited for DHH/BVI students as the conversation had moved on by the time they were able to consume the information. This also made students reluctant to contribute for fear of misinterpreting the conversation and/or saying something that they thought other participants might perceive as 'stupid'.

Technical problems with sound quality (varying levels, muffled or distorted sounds, multiple simultaneous speakers) also presented barriers, making the aural communications even more inaccessible for those with hearing loss. The problems of juggling the voice of a screen reader in conjunction with other aural communications added an additional level of complexity.

Tutors' reactions to disability and the adjustments they made were also producing barriers, from the need for repeated declarations of disability with different tutors/peers, to the inexperience of some tutors in knowing how to adapt and adjust their teaching methods, activities, and materials in order to facilitate inclusion.

Unfamiliarity with aspects of the online collaborative process led to students choosing not to engage- unfamiliarity with tutors, peers, the learning environment, and materials. This was also exacerbated by students feeling unheard, and unsure of what was required of them so tending to take a more passive, observative role.

Disengagement was often an option to avoid 'struggles': to be heard/seen, to ask for adjustments, to declare disability and to ask for a session to be slowed down or adapted for their needs.

The key lessons learned from the survey were that:

- Yes, DHH/BVI students are experiencing barriers to engagement with online tutorials and live learning events.
- Some of the key barriers were identified as outlined above
- Many barriers are likely to be undetected by tutors and the institution as students are electing to opt out, take a passive role, or disengaging from collaborative learning processes as a result of the barriers they face
- Participants expressed a lot of frustration with tutorials. Some of these are likely to be applicable to all students, others seem to be exacerbated by sensory impairment.

The survey data is revisited in section 5.3 where a quantitative data analysis of the dichotomous and Likert scale responses was undertaken in order to triangulate data from both qualitative and quantitative analysis.

5.4 Interviews (P1S2, P2S3)

Interviews were conducted both to 'mine' data and find key pieces of information, and as a 'traveller' with the intention of travelling with the interviewee as a partner into unknown territory. (Cohen & Manion, 2017, p.506). With the students selected as interviewees from the survey data, the intention was more of a mining approach using more specifically tailored questions to find the reasons behind, and delve deeper into, the experiences they had noted on the survey response. With other students and the staff participants there was more of a travelling approach to understand the issues from their perspectives and experiences. Interviews allowed the issues to be explored in greater depth and new issues to come to light. A semi-structured interview with open questions allowed for prompting and probing on issues that might inform the research questions.

5.4.1 Introduction

Choice of student participants was determined by identifying candidates from the survey respondents with a view to exploring in greater detail and from different perspectives the themes and areas of interest arising from the survey (P1S1). These were participants who had provided feedback on the themes, but which suggested there might be more information to be gained. These included: Experiences and access/provision to support for DHH and BVI students, the use of assistive technology, and actions taken and options to address access issues

The additional candidates were identified by role and experience to provide a representative sample of all stakeholders in the online collaborative learning process.

Table 68 - Interviewees

Interviewee	Role	Description	Disability
Student 1	Student	Very limited hearing studying at level 2 on Open Degree.	DHH
Student 2	Student	Profoundly deaf following study at level 2 in STEM.	DHH
Student 3	Student	Visually impaired – some vision but uses both screen reader and magnification software.	BVI
Student 4	Student	Blind. Uses screen reader.	BVI
DSG	Student	Committee member of the Students Association, Chair of the Disabled Students Group.	DHH/BVI
Academic	Staff	An academic with specialism in accessibility.	Manual Dexterity
AL	Staff	Associate Lecturer/Tutor in STEM (Maths).	BVI
ST	Staff	Staff Tutor in STEM.	-
SSO	Staff	Student Support Officer.	DHH

This enabled a broad perspective covering both staff and students and BVI and DHH experiences.

5.4.2 Summary of findings from each interview

The intention when planning the interviews was that as many as possible would take place face-to-face, and with some of the earlier interviews this was possible, however due to the pandemic all later interviews took place online via Adobe Connect. This choice of online environment was determined by University policy at the time (GDPR and pandemic ways of working guidelines), the access participants had to the environments, and through mutually agreed modes of communication. Choices of visual and audio recording was determined by both the environment and the participants.

Transcriptions were made of the aural communications and a visual review was also undertaken to pick up on any non-verbal communications. This approach is expanded upon in the discussions section.

5.4.3 P1S2 Student Interviews

Student 1 (DHH)

This interview was held in Adobe Connect and primarily via text communications in the chat pane and a shared screen resource (whiteboard). The communications were saved as a text document and quotes used unedited.

Students were initially asked to talk about their hearing and or sight and Student 1 explained that "I have a hearing impairment since birth where my auditory nerves don't work correctly so I hear well at upper and lower frequencies but not much in the middle, so I rely on hearing aids and lip-reading." This echoed the diversity of hearing impairment indicted by the survey, with students hearing in different ways, such as some with high pitch loss, some mid and some low. What can and cannot be heard at any one point can be different with the diversity of hearing levels and the nature of the impairment with DHH students.

This student again reinforced the indications from the survey that face-to-face tutorials were more accessible, in stating that she had managed in face-to-face tutorials as long as she could see the tutor. She stated that she just sits near the front in order to do this and no further adaptions are necessary.

When working with other students in small groups she explained that she had generally positive experiences of face-to-face tutorials but can have issues with noisy environments "so it can be a challenge to hear people next to me when there's lots of background noise but as long as I can see the speaker I can usually understand." In the context of face-to-face she stated that "any issues were no more than I have in day-to-day life anyway" and that she had "always really enjoyed the f2f experience. I like meeting other students and having a chat about the joys ;) of distance learning. I like being given different activities to do with the course materials and using the knowledge I have gained." On the move from face-to-face to online tutorials she stated "For me, it changes the way I think of the OU and my course if I have lost that connection to tutors and other students that I used to get from f2f. For me the online sessions don't replace that." So, whilst the face-to-face experiences had been predominantly positive this was not true of online experiences. Recognising the lack of social connection and cohesion she felt was offered online in comparison with the face-to-face experience was an important factor for her.

The student had live transcription/captioning in place for tutorials which involved a third-party joining the sessions and typing captions specifically for the student which would appear in a separate window to the session. Whilst the relationship with the captioner (referred to by the student as the subtitler) seemed to be reasonably effective, the student experienced problems with the understanding of the tutors in how to work with a captioner stating that "in the adobe connect sessions the tutor needs to speak at a reasonably slow pace so that the subtitler can type everything they say but not all tutors do this. The last tutorial was a disaster! The subtitler, myself, and another deaf student kept asking them to slow down as the subtitler couldn't keep up. It got so bad the three of us had to abandon the session altogether. Also, because the material is quite technical and the subtitler is not an expert in this area it's hard for her to keep up." This raises a number of barriers faced, further supporting the findings from P1S1 relating to the importance of pace and speed of the tutorial, the importance of communications between tutors and facilitators, but also the problem of getting accuracy in subtitling from a non-subject specific captioner. With specialist subject areas there is perhaps the need for the captioner to be briefed on the topic of discussion and specific words or terminology that might arise. This was picked up and explored further in the interview with the staff tutor.

Synchronising the text communications with the speaker was also raised as an issue as there is an inevitable delay "there is someone typing subtitles live from the speech, or trying to! It doesn't really work". The appearance of the captions in a separate pane was also explained "the subtitles are in a separate window completely from the Adobe session so you have to tile your windows and juggle them around, I've never managed a satisfactory layout that allows me to see everything clearly"

The student also mentioned having encountered core material that was inaccessible in the form of an Adobe Connect recording with "no webcam/subtitles/captions/transcript." This was listed as an activity that the student had to complete.

The problems of being unable to lip read online were explained. When webcams were used they "often didn't work and would freeze making lip-reading impossible. Apparently, the issue with the webcam is due to the number of attendees causing bandwidth problems." Having to manage without visual cues raised the problem of juggling communication channels "So, when I am in the session, I am having to watch the actual slides in the presentation, listen, watch the chat box for questions/comments AND read the live subtitles which lag behind the speech AND try and decipher them, all at the same time."

Returning to tutor response the student gave an example of lack of understanding or training when working with students with disabilities, as demonstrated by a tutor: "In the last session I typed a question in the chat box and the tutor replied verbally, so I typed that I was deaf and she apologised, verbally, but still didn't respond in writing."

Frustration with the barriers encountered and the complex processes required to try and obtain accessible access to tutorials was expressed "I have lost count of the angry, frustrated emails I have sent to the OU over the last couple of years since they did away with f2f tutorials, and they just can't engage with what the issues are." So there seems to be a fundamental lack of understanding and dissemination of information throughout the process. The result of her frustration was for the student to opt out of the online tutorial sessions stating "I've given up attending tutorials now as it is a waste of valuable study time, I get nothing from them, and I am left feeling frustrated, angry and like some weirdo who is being fussy."

The student also talked about the importance of recordings, and how they needed not only captioning but accurate and timely captions, mentioning materials where speech and visuals were "completely out of step so they are impossible to follow".

Key findings from this interview helped expand on some of the problems with captioning live sessions. Live captioning for tutorials and scheduled online collaborative activities was only available for students with declared disabilities and required organising and arranging in advance with student services, the tutor, and a live captioner. This all added administrative burden to the student making attendance more complex and time consuming. There is also the problem of how to replicate online the elements of face-to-face that the student perceived as providing a more accessible, sociable learning environment.

Student 2 (DHH)

This interview was held in Adobe Connect using voice and webcam. The student relied on lip reading and webcam usage for communication during the session as no provider captioning or BSL interpreter was available but indicated that she was fine with communicating in this way in a one-to-one interview. The audio and visual communications were recorded in Adobe Connect and transcribed.

The student described herself as profoundly deaf. She uses Dragon voice-to-text software and an additional device that allowed her to translate audio directly to Word.

Like Student 1 she emphasised the need for subtitles on material but also raised the point that these subtitles are often difficult to follow "Some of the videos don't have subtitles, or some … 'translate', or the lip-sync is just out. It doesn't go with the subtitles." This supported Student 1's experiences of problems with material sub-titling.

Whilst Student 1 had relied on self-advocacy to get the adjustments and highlight the barriers she was encountering, Student 2 had take a more passive role, mainly choosing to avoid learning experiences where her impairment might present barriers. The key areas of concern that came up with Student 2 were decisions to opt out from all group work or sessions that involved peer engagement. In the case of this student, it was not just opting out of tutorials or online sessions but actually dropping out of a module when collaborative online activities were required as part of the module. She had made use of the one-to-one tutorials that were available through student support and attended some tutorials but "only where the tutor leads and has less collaborative aspects." She had used forums but did not find them useful. Whilst there were residential schools available for her modules, she stated that she had not gone to any of them as she "just didn't feel confident enough to go."

When asked if she would go if she knew it was accessible to her, she said she would. Her concerns were "Just a bit of everything. Whether you are going to be able to see the tutor's face, how they are going to be, how aware they are of the situation.   You've also got to take into fact background noises. Other students talking to you, what they're going to be like. There is a number of other things as well, not just, whether I'm going to hear the teachers." Unlike Student 1 there was not the contrast in feelings and perceptions of online and face-to-face tutorial experiences as she had chosen to opt out from both forms of tutorial.

This avoidance of collaboration with other students extended to her choice of module and she revealed that she withdrew from a biology module the previous year because there was "a lot of collaborative work. Experiments and things like that as well." These experiments were performed as a group. She explained "there's no point. I couldn't see the point of wasting my time if I can't hear what people are saying. I feel I'm not included as a group, but if I had more one-to-one sessions then perhaps…" This raises some areas of concern, being excluded, and the inaccessibility of the activity, but also suggests that interventions in terms of building confidence and familiarity with the environments, people, and expectations with one-to-one sessions might be a way to reduce these barriers.

She re-iterated the importance of being able to see people in online situations, and how typed responses and contributions to discussion helped. "If you don't want to (appear on webcams) that's fine, I respect that. If they typed I'd appreciate that so I could see what they were saying."

In her relationships with tutors she had more positive experiences saying that once aware of her hearing they have been quite supportive.

Student 3 (BVI)

This interview was held via phone, audio recorded and transcribed.

Student 3 described themselves as blind and used a screen reader (NVDA) whilst online.

The student talked about having lots of problems with materials. They found the module sites and materials reasonable but for tutorials often had trouble getting hold of slides in advance, and when they did receive them they were not always screen readable. Objects on slides were often unnamed and in random orders so it took a long time to work out what was going on and in which order on each slide. They said "it is really rare to get slides that you can read 'normally'. There will be lots of items - I have no idea what they are. When you get one that is easy to follow it makes such a difference." They explained that during a tutorial they would have the slides open in a different window so they can follow. "I switch between Adobe Connect and PowerPoint which can get a bit messy, and I sometime lose track of where I am."

One of the main problems they encountered was that their screen reader not working on lots of areas in Adobe Connect and they were not always sure where on the screen to look for things like polls or reactions. The student stated that they found it easier with the old system (based on blackboard) but, when prompted, didn't really expand on why.

When talking about using a screen reader the student was used to having screen reader set at a fast pace read, and consuming content quickly but still found it a lot to juggle. They talked about trying to listen to conversation or the tutor at the same time as reading the slides and having to "mess around and switch between things" in order to pick up all the communications going on which could be "quite difficult".

Key things that emerged from this interview were that synchronising and juggling communications from different sources is complex when utilising assistive technology, and that materials need to be accessible and designed with screen readers in mind. This means making sure all elements have descriptive (alt) text, that the tab order is correct, and that all elements are readable. Whilst the student in this interview had good relationships with her tutors and was used to negotiating her needs at the start of each academic year, she acknowledged that this was often “time consuming” and repetitive.

Student 4 (BVI)

This interview was held via Adobe Connect, video and audio recorded and transcribed.

Student 4 described themselves as visually impaired and explained that they had limited vision but could read under certain conditions (extra-large print and good contrast) and often used a handheld magnifier when reading offline or an on-screen magnifier when reading online. They talked about their learning environment and the need to have control of it: to know where things are or should be and to have a familiarity with physical layout of their working environment as well as the virtual layouts of online environments.

One of their main concerns was the pace of session as it took them longer to find things on the screen, to process the information and to identify areas of discussion. He stated “when they are sharing a diagram or something on the screen I can only see a bit of it at a time so can’t always work out what (the tutor) is talking about.” They explained that normally when reading on the screen they had the text at a really large font and spread the width and breadth of the screen, and when they did this, they managed to read at “a normal pace so I can keep up”.

The student explained that they did like face-to-face tutorials but “need to be at the front as I can’t always read projected screen”.

Key findings from this interview were that the student needed to have some control over the layout of the windows in the screen and the ‘pods’ within the learning platform so that they might be optimised for his use. Pacing of sessions to allow time to navigate was also a requirement.

DSG (DHH and BVI)

This interview was held face-to-face, and audio recorded. She described herself as paraplegic with both visual and hearing impairments. The interviewee was active in the Student Association’s Disabled Students’ Group (DSG) at the time and oversaw “anything that is to do with disabled students whether they have declared or not declared.” This was important to her as she recognised that there were many students at the University that did not declare disability through formal channels but "they often declare in our closed forums". She felt that the main reason for non-disclosure was that students were afraid of their disabilities being in the public forum and the potential implications (whether real or not) for this declaration impacting on employment, student finance, or benefit claims. "We know students by name who don't declare outside. Which happens in any place, because in a lot of businesses people don't declare anyway and even though we say that things are closed, and the Open University won't pass things on, people are scared under GDPR that maybe their employer gets to know, or it might go against them when they are applying for a job. It's very difficult."

She emphasised the importance of declaring and how that then opens resources and support channels for students that they may not have been aware of. This echoed the feedback from the survey about the general lack of knowledge of what support services were available and how to access them. She talked about her personal experience and of how "all of a sudden, miracles happened because everything opened up and I could apply for disability students' allowance. I'd had no help with accessibility. I had nothing … everything just opened up it was like somebody opening up a set of double doors." What emerged from this interviewee here was the importance of improving access to support. There seemed to be a necessity to declare in order to get this and the onus was on the student to make that declaration. She related this to her own experience of declaring disability "I was visually impaired before I had an accident and became paraplegic, I was a paraplegic before I realised I was disabled. In actual fact I'd lived with the hearing loss and visual impairment for years. So, I never ticked the box saying that I was disabled and I had been studying." There is perhaps, still, a stigma attached to the notion of being 'disabled', or alternatively a feeling of fraudulence, which means students with sensory impairment are less likely to declare unless profoundly deaf or blind. She added that "a lot of people say 'Oh, I don't know what I would get out of it, I don't consider myself disabled, I've only got hearing loss', I was down that road. So it takes people sometimes, unfortunately, to get to the crisis point."

She talked about the complexity of assistive technologies and the advancements of technologies over the years she had been a student. This covered the problems of finding a technology that suited her needs and the time taken to learn how to use them effectively and what does and does not suit a particular student. There were also different recommendations from different faculties and units dependent on the activities and material in use. One of the key aspects of reducing the barriers for her personally was getting the use of a third-party assistant (referred to as a non-medical helper). Once this was in place she stated "that alone makes such a difference. Because what I couldn't search for, and what I couldn't find by listening, the non-medical helper does. People assume it's technology that helps you with loss and visual impairment, they don't realise how much those hours of non-medical help make a difference.” As a long-term student (she had first enrolled in 2009) she reflected on how familiarity with technology, process, equipment was important and how finding the best assistive technology for individual use was a complex process with multiple options and criteria.

She also talked about the limited number of help hours disabled students are allocated and the need to make decisions as to how best use those hours “If it is collaborative work that gets me 10% of my TMA, then I will do it (use hours). If it is collaborative work that is voluntary, I have to balance.”

Balancing different technologies was a subject that was returned to on a number of occasions, and again this was something she had learned to manage through familiarity and experimentation over the years. She used multiple entries to an online meeting room to manage different aspects, listening on one, using a screen reader on another and with the non-medical helper using a third, to describe content like whiteboard content to her “it just takes a bit more planning”.

She talked about declaration again, but in the context of peers and group working. Often in these situations students are forced to declare their disabilities when they might not want to in order to make other students aware of ways in which they can and cannot contribute and how to include them in the activities. She gave an example of making shared documents understandable to a screen reader “if they put in a lot of acronyms, and they don’t space some of them, for example D.O.G. stands for some group, right, and you put in DOG together I hear it as dog. If it’s right in the middle you’ll get some of these queer names and you’ll go ‘eh? what are you talking about?’. You know, so it knocks you off. So you are having to remind folk, say they put in a graph and say comment. You know, don’t tell me what it’s about. Or put in an image. But I need to listen to what the image is about.”

The issues around getting timely support in place was raised again and the inaccessibility of Adobe Connect. She emphasised the importance of getting information into their student profiles so that these were available to tutors and moderators in activities. She broached the problem of dissemination of information and procedural problems “the unfortunate bit is at the very beginning the OU isn’t explaining enough. The biggest problem is the first collaborative session. Because you don’t know people you haven’t got to meet them.” This again supports the importance of familiarisation with all aspects of the learning process and environment.

There is often a time delay in getting specialist equipment and technology in place, so unless this is managed more efficiently students will not have the support they need in place at the beginning of their study. She talked about how the DSG could support students with this “it’s about timely support and continuous support throughout the journey and actually getting them to realise how far they have come on their journey already." They also were able to advise on utilising the equipment they might already have "using your own basic equipment in a different way", such as voice to text on mobile devices, or build in text readers. This can give them support until their needs are fully assessed.

5.4.4 P2S3 Staff Interviews

These interviews were aimed at getting the providers' perspectives on some of the barriers identified, understanding what services were in place, and how they could be accessed. In addition, each different role could gain an insight into different aspects of the learning environment and how it is accessed and used.

Academic

This interview was held face-to-face and was audio recorded and transcribed.

The interviewee was an academic with expertise in accessibility, particularly visual impairment which had been the focus of her doctorate. Her role at the time of the interview was in the SeGA (Securing Greater Access) Team at the Open University.

She stated that, in her experience, visual impairment is "always the one that needs the most technological adaptations". She also suggested that synchronous situations are probably the most problematic for DHH students as "you could have asynchronous text chatting sessions in which hearing-impaired students probably wouldn't be at a disadvantage. But I think certainly if it is using audio, teleconferencing then yes, it is more difficult. And then yes for visually impaired students as well. They need the time to navigate around the screen as well as maybe having the conversation or engaging in materials."

She explained how she had recently started using Dragon (speech recognition software) because of experiencing Repetitive Strain Injury (RSI) issues and "my productivity has plummeted. To a really concerning level I would say. That's given me strong insight into… I mean I always knew that using assistive technology was another layer on top of your work. You are dealing with your impairment, you are dealing with your learning, and you are having to deal with the assistive technology. I was always aware that that was another layer, and I knew that for screen reader users there is quite a steep learning curve." She continued that it involved not only learning the concept of the tool, but then learning all the commands of it. Finding herself having to use Dragon in a work context she stated, "I've just realised what a huge impact that has."

It is clear that the use of assistive technologies has an impact on the workload of students, and that (as suggested by the DSG student interviewee) it takes time and practice to gain a familiarity with assistive technologies and to get the full benefit of their use.

She suggested that accessibility has generally improved for disabled students and has more visibility across the University. "I think it is less of a surprise when you ask people now about accessibility. I think over the last few years accessibility has become much more of a priority in the institution, so it is less of a surprise when you challenge people and ask them about accessibility." This suggests a culture willing to listen and to adapt. However, she expressed concern about recent changes in goals and objectives for the University whereby in the equality scheme disability for students is no longer mentioned. "Yes, disabled students are no longer mentioned in our equality schemes because it is supposed to be moving towards business as usual for all the units. But units don't know they need to be looking at disability as business as usual. They will just look at the equality scheme." This suggests that there is a perception from the University that accessibility is already in place and therefore not a priority, but evidence from the students suggests that this is not the case.

An area she highlighted where changes had been effective was the procurement processes "I guess we've built accessibility better into procurement processes. For buying third-party technology. I think that is improving. It is not perfect."

The interviewee touched on why she felt that students prefer not to engage in collaborative activities, indicating that students often appear to be happier studying by themselves. She suggested that they may think "I'm in control and then I'm doing my learning and I'll be assessed on that and I don't need to work with other people." while she suggested this may perhaps be a naïve position, she thought that some students specifically choose the OU precisely so they can study by themselves.

She shed light on some of the problems with supporting students in synchronous group learning events. For DHH students she explained that "we have no core provision for captions, transcription, or notetaking generally in adobe connect sessions. Everything we offer is on an ad-hoc individual basis. So, for a live session… so for a recorded sessions we may provide captioning after the event. Some individual students get live captioning, but it is all adjustments for them as individuals it is not a core provision." So, whilst there is provision available, every individual student with additional requirements for tutorials has to make their own personal arrangements and do so for every tutorial or group activity undertaken.

She raised the issue of other participants, both tutor and students, not "necessarily knowing how best how well to work with someone with an impairment." which she linked with the broader subject of disclosure and collective responsibility.

"We do have note of disclosure issues. I think there might be some non-disabled students who think 'well this is not really my role' if a visually impaired student asks for a word document instead of a pdf from their peers, their peers may think well it's not up to me to create an accessible version of this, of course in a loving, collaborative human environment we would want them to go 'of course' but they may not see that as their role and they may see the University has the responsibility to provide the accessible materials." She referenced some work they had done in the past in the context of student generated content, and how they had talked about how working with disabled people should be perceived as a great employability skill for everybody and something you could put on your CV. She talked of it being seen as a life skill and how "the students should be encouraged and supported. But they need that support to learn how to do that, you can't just expect them to end up in an Adobe Connect session where a student pipes up and says I'm visually impaired and I need some support." The pressure on the disabled student to disclose their disability in order to get help or the adjustments they might need from both the University and their peers she felt was a significant barrier. She also raised the subject of assessed group activities and how "if the group activity is assessed, and sometimes they are peer assessed, that could really become a problem too. If the disabled student had been perceived as a burden they may get marked down. If a peer had failed to support the disabled student in whatever way they asked, then the student might mark them down. So I think it's really tricky." She linked this back to the need to "not just responding IF a disabled student is participating, but actually being designed to participate."

She felt it was important for the research to "capture their lived experience of the sessions. What it is really like for them to encounter either a technology that's not that accessible to them or a way of working that is not very accessible to them. You know, how does that make them feel? What impact does that have on their learning? And on them as a person." So emotional and social factors were deemed to be important for the interviewee.

When we discussed the specific problems relating to the platform being used for group work and tutorials (Adobe Connect) she was able to shed some light on the reasons for adopting this technology and the complexity involved. "One other barrier that is going to make a difference which is really an institutional barrier, is about the procurement of technology. The perception is that we didn't think about accessibility when we adopted Adobe Connect and that is not actually the case. We did spend a lot of time thinking about accessibility and testing the different products that the suppliers were offering but the truth is that none of them were fully accessible. None of them were entirely accessible to screen readers, none of them had automated captioning …and we had to go with the product that met the functional requirements. If you think about all the requirements for the different types of tutorials, different types teaching events, and breakout rooms and whiteboards for teaching maths and all those other functional requirements. Adobe was the only one that met all of those. And yes, it was a compromise, but it was an understandable compromise …it is a really, really thorny and tricky issue."

AL (Associate Lecturer)

This interview was held via Adobe Connect and video and audio recorded and transcribed

The interviewee was an experienced maths tutor who described herself as partially sighted. "Very short sighted in one eye and no sight in the other eye which of course affects field of view a lot."

She talked about the variation amongst people with visual impairments and how "people who don't know about sight impairments seem to find it hard to understand what I can see and what I can't see. She explained how she processed and consumed reading matter "I don't magnify text at all when reading from paper, I just hold it really close. I guess that's a bit unusual. Sometimes on screen I do magnify a bit because I find it a bit…there's more glare on the screen so a magnifier helps a bit with that. So it's just basically sitting very close to the screen and using a monitor arm to move the monitor forward." This supported the findings of the survey regarding the diversity (as with DHH and hearing) in how BVI students 'see' and how differently they might consume materials. She talked about how misunderstanding different levels of vision often led to people in face-to-face situations who didn't know her "making comments about my eyesight and offering help where it's not really needed, and misunderstanding what level of help might be required." She talked about how the culture in the OU seems quite different "far fewer people do that."

The anonymity online, where students and other staff members may not be aware of her disability, she perceived not as a barrier but as something that required less explanation. She also talked about her own academic journey and the fact that "academia was just letting me get on with it and not trying to… I mean, I don't mean that they wouldn't have provided help if it was needed…".

She raised an interesting issue in relation to a face-to-face tutorials which she had every couple of weeks with a particular student group. One of the students was profoundly deaf and used lip reading and had asked her to face her every time she was speaking. This she described as "quite an adjustment to get used to" as she was unable to clearly see the student. What she found trickier with the group was when the deaf student wanted to know if other people were going to speak.

They were collectively working through maths problems and attendees were asked to contribute suggestions “we’d normally be working through problems, and I’d be asking people to contribute suggestions as to what to do next, that kind of thing. So normally all sorts of people would be calling out, and she wanted to know if they were, so she didn’t call out at the same time. So, then we suggested that people could put their hands up. So we tried that (laughing) and I couldn’t see whether they had their hands up! Obviously, the combination of things brings out different problems.” This echoed the contribution from a staff tutor who talked about an occasion at a tutorial where a neurodiverse student asked a BSL interpreter, who was attending to translate for a deaf student, to stop moving her arms and body around during the session. In that instance they physically rearranged the people so that the student that needed to see the interpreter could, and the one that found it frustrating could not.

She felt strongly that face-to-face was much more conducive to collaborative working “one of the things I’ve found is that, on a face-to-face, because you are actually interacting with people in a very real way, it’s easier to sort of, you know, you find solutions around it, don’t you… in some ways, but I’ve found that sometimes students don’t want that to be discussed in front of the rest of the group.”

Returning to the subject of declaration, she raised the point that as a host you are normally aware of people’s disabilities because you can access their student profiles, but other students within the group will not have access, and therefore making adjustments is harder as people are “less aware of when something is becoming inaccessible or difficult to engage with.”

She described Adobe Connect as a “blunt instrument in terms of encouraging interaction.” Emphasising the problems with encouraging interaction and engagement she stated “you have to work really hard to find a way to structure a tutorial in such a way that people interact, and I’ve even done the same question in a face-to-face tutorial and it’s just amazing the difference. So much more interaction. And people, the same people in some cases were in both, and they ask questions in the face-to-face one that they didn’t ask in the online one. I just thought, (sighs), that just to me it’s just not conducive to engagement.”

She talked about the students lacking cohesion as a social group online “I think they are removed from what’s going on and each other, so they can’t pick up signals from each other.”

She also talked about how it was harder for her to engage and manage a session online “that’s an issue for me myself because, well because my field of view is smaller and because my face is very close to the monitor I’ve got to keep looking from what I’m doing on my slides to the chat panel on the right and I have to keep looking across and I wouldn't notice, if I wasn't keeping looking, I wouldn't notice when it moved up with someone adding to it so…"

She talked about pacing also, and her experience as a participant in a session rather than as facilitator/presenter "I just find that when I'm the participant sometimes people point at something very quickly to show you what to look at and then move the pointer away very quickly, and I haven't had time to find it on the screen because of course I can only see a small bit of the screen at a time, being nearer to it and having a smaller field of view. Then I miss what they've pointed at."

This interview raised some of the issues about ease of engagement, online versus face-to-face, the necessity to disclose disability in order to get necessary adjustments, and the problems with managing different disabilities with conflicting requirements.

ST (Staff Tutor)/Module Team

This interview was held face-to-face, and audio recorded.

The interviewee was a staff tutor and module team member in STEM. The focus of this interview was how students were being supported and how and what adjustments were available.

She explained the administrative difficulties of organising support for deaf students for online sessions. An example was a biology module where there were three DHH students within the cluster group for the module. A live captioner was being used for sessions. She talked about how the adjustments were allocated on a student-by-student basis so that only the specific students who had been authorised to have adjustments were allowed access to the live captioning. This captioning was presented through an additional programme independent of Adobe Connect and in a different window. The captioner, though efficient and quick, was not a subject specialist so interpretation of the terminology and words used had caused a few minor issues where the subject terminology was not understood or had to be clarified. She explained that whilst they had access to some "really good, fast captioners" they were "on occasions not able to correctly interpret the tutor because of the specific technical language and concepts being used" which led to interpretations which were not clear, or concepts not fully understood. As the captioning was not accessed by the tutor the timeliness or accuracy could not be followed, and the tutor had difficulty pacing themselves appropriately to accommodate the captioning. This raised a lot of issues in terms of the procedures for captioning. It suggests that when third-party captioners are used there needs to be better communication between student/captioner/tutor, captioning should ideally be available for all participants in a session, and terminology and potentially difficult or complex content needs to be discussed with the captioner in advance. The way the captions are presented is problematic too with the additional program and window requiring switching back and forth between programs and windows to follow a session.

SSO

This interview was held face-to-face and audio recorded. The interviewee was a full-time staff member in a student support role dealing with enquiries and complaints and negotiating with other institutional staff to resolve them. She was also a part-time student herself at the University.

The interview focussed mainly on discussion of adjustments for students, transcription, and the need for self-advocacy.

She raised a number of issues around the recording of tutorials and their availability after a session. She talked about the tutorials summaries as “audio only files or they are audio visual files. There is no transcript option. There is also no information for the students that they can request a transcript.” She was pushing students to request transcripts with the hope that if enough students did this on a regular basis the faculty would be pushed to provide these by default. She felt that transcripts should be “as standard”. She also acknowledged that this was not the end answer and that there needed to be some movement on Adobe Connect providing subtitles and other means of communication. Whilst the students can request captioners she highlighted that “these are all things that the student finds difficult to know and find out.”

On the need for self-advocacy, she noted that “my experience as a deaf person, not just a deaf student but a deaf member of staff, is that I keep having to ask for what I don’t think of as unreasonable help. I spend my life asking people, it’s on my emails, it’s on my profile I don’t want to keep saying I need this.” She talked about the fact that “you can get by” but that this is not really satisfactory. “I’ve been to meetings where I have no idea what is happening. I just hope I don’t miss important stuff!” She also raised the issue of presumed agreement in a meeting where because nothing had been said or objected to consent was presumed, whereas in fact she had been unable to hear the suggestion. “It gets tiring having to ask people to say things again and again and I think that is the main problem”. This indicated that there are implications for DHH students in group projects where misunderstandings can occur, and other group members may see this as negative behaviour: failing to do something in an agreed way or to deliver their contribution to the group.

She raised the need for training and support on DHH issues. “One of the problems the University has is a lack of training and information about deafness. There are advisors for other disabilities but there is not one for deaf. “

The subject of the limitations of existing adjustments was raised and how a more holistic approach is needed. “A lot of deaf people communicate in non-verbal ways and the accepted way of making adjustments is just to provide a transcript, or just to provide subtitles, I speak BSL and when I do you lose all of your sort of connections and if I am having a mostly BSL day I have to get myself out of emailing in that way, it can get confused so we do need to have non-transcript ways of communicating.”

She reinforced the issues relating to the multiplicity of ways of communication, needing to choose what is best for the student in a specific context, and allowing the student to have control over these means and ways of communication.

5.4.5 Thematic analysis 2 – new and revised themes

The transcripts from the interviews were added to NVivo and all content re-coded and adjusted to better represent the combined data set which produced additional codes and adjustments and reallocation of existing coded content.

Code Changes

Navigating screen, Assistive Technologies and ***Screen Reading*** were merged into ***Screen Reading, Assistive Technology (AT), and Navigation.*** This covered all aspects of ‘consuming’ a screen, whether visually, using magnification, using assistive technology, or using keyboard or mouse. Although ATs are technology it is the screen reading aspect that is more relevant here hence their movement from the Provisioning and Technical category to Communications.

Lip reading and ***Seeing People*** were merged into ***Lip Reading and Non-Verbal Communications (NVC).*** Most references to seeing people related to picking up communications visually from a person: body language, gesture, lip reading, and facial expression so these were grouped as Lip Reading and NVC.

Sound Problems, Unable to Follow/Participate and ***Unable to Hear*** were merged into a new code of ***Aural*** communications. These all related to problems consuming aural communications.

Two new codes were created in the communications category: ***Synchronisation*** and ***Interpretation/Assistance***. Synchronisation recognised the important of voice/text/captioning/interpretation being synchronised so that students could keep pace. Interpretation and Assistance references the use of a third-party in a synchronous learning environment, such as a BSL interpreter, a live captioner, or a non-medical assistance (NMA) to facilitate communications.

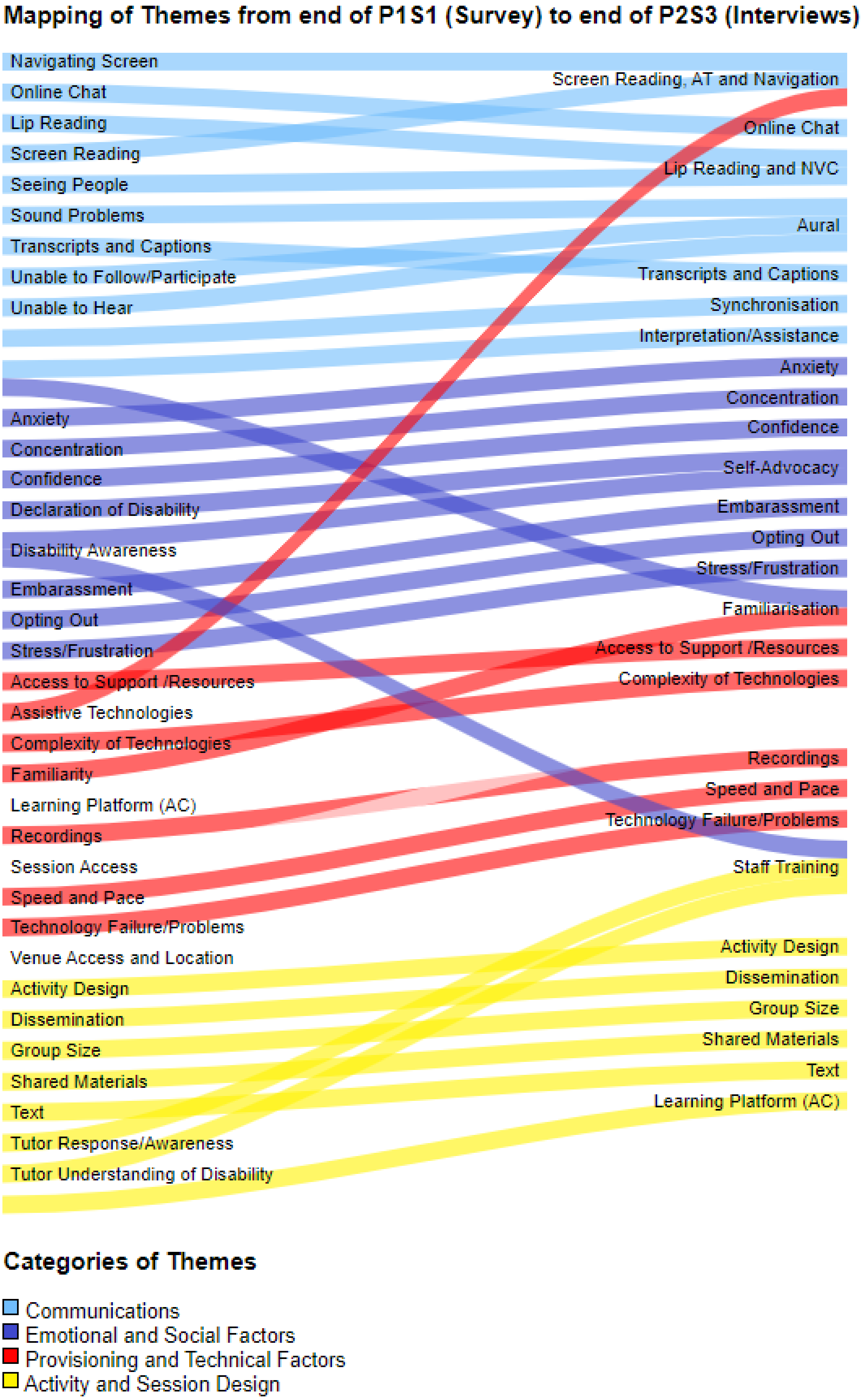
Familiarisation was added as a new code. This code represented barriers presented by the unknown, be it people, environments, expectations, technology, or protocols. This replaced ***Familiarity*** previously in the Provisioning and Technical category. ***Declaration of Disability*** and ***Disability Awareness*** were merged into the new code of ***Self-Advocacy,*** with some coded statements from ***Disability Awareness*** being allocated to ***Staff Training***. This related to the fact that students needed to ask for adjustments and be pro-active in declaration in order to do so. Where staff were lacking in knowledge about disabilities and how to support students this was seen as a ***Staff Training*** factor.

Learning Platform was re-allocated from the Technical and Provisioning category to Activity and Session Design as the majority of coded references related to the design, function, layout, and usage of the learning environment and the technical or provisioning issues were beyond the scope of this research.

As the findings from P1S1 confirmed that synchronous online environments posed the most significant barriers to SI students the codes ***Session Access*** and ***Venue Access and Location*** were both dropped as they did not relate to synchronous online activities but mainly related to travel and physical access to venues for face-to-face tutorials or navigating to a session in the online environment which is encompassed in screen navigation. These themes had provided useful insight into the reasons for students' preferences for face-to-face or online tutorials.

The mapping of codes between the end of P1S1 (the survey) and after the interview phases is shown in Figure 15 Theme Changes #1.

Figure 15 Theme Changes #1



5.4.6 Reflections on Areas identified for more research from P1S1

The aims of the interviews had been to expand on the areas identified in section 5.3.3 which are revisited below.

The use of assistive technology in collaborative work: The interviews helped to better understand the use of assistive technologies and the barriers relating to this. Both the academic and the DSG representative emphasised the learning curve associated with adopting assistive technology and the additional burden this places on the tutor. Much of the focus was on screen readers, and this highlighted barriers caused by inaccessible materials, lack of training of staff in both how to prepare accessible materials and how to manage a session when students are using assistive technology. Learning to juggle screen reading with other communications, and finding a working setup that allowed effective use of the technology in the online tutorial context, emphasised the need for both control over the environment and time to gain familiarity with the technologies in order to build confidence.

The invisibility of students online emphasised this lack of understanding from the tutor perspective as they are often unaware that ATs are in use, or how they might adapt their sessions to accommodate them.

The use of interpreters: This area exposed a wider concept in that the use of third-party participants, as interpreters, captioners, note-takers, or non-medical helpers all presented additional engagement problems for SI students. These problems related mainly to the accuracy and timeliness of the communications which impacted the students' ability to engage and contribute. Issues encountered include aspects such as translation accuracy, different interpretations of meanings, time delays, and speed and accuracy.

Captioning and Transcription: as well as the use of captioners assisting students in live sessions, the more general use of captioning and transcripts and the problems these created was expanded upon. The use of recordings of tutorials, to support learning and to encourage participation in subsequent sessions is important. The need for accurate captioning which is synchronised with content and available at the appropriate time in the study program supports engagement.

From the staff perspective issues around the provisioning of captioning and transcription services emphasised the burden place on the student to request these, rather than them being available by default.

Designing/implementation of accessible materials, activities and environments:

More was learned about how and where materials and activities were failing in terms of accessibility, and the importance of staff training in producing accessible materials.

Staff training and awareness of working with students with disabilities: Whilst staff were perceived as willing to help, their understanding of how to do so was often limited and practices did not help. The lack of both dissemination of information and communication between tutors and interpreters/third-party assistants highlighted this problem, and general lack of training in accessibility and inclusion.

Processes and provisioning for reasonable adjustments: students were either unaware of, or frustrated with, the processes and provisioning for reasonable adjustments so clarity on the services available and the processes for implementing them was required.

Reflection on New themes and Changes

The new code of synchronisation was created to cover aspects of misalignment between communications. These occurred in a number of different ways but essentially put the sensory impaired student out of synchronisation with other participants, resulting in problems following and contributing to the discussion. When an interpreter, captioner, note-taker or other third-party assistant was included in an online event it distanced the students from the group in that most communications were taking place through that third-party and therefore the student was having very little direct communication with their peers or tutors. The third-party was, in many cases, unable to convey all of the communications due to the pace and multiple communications taking place, so there was inevitably some filtering taking place. If the student wanted to contribute the process of passing messages through a third-party often meant they were disjointed, and the conversation might well have moved on. If the third-party was not a subject specialist then the accuracy of the communications could not be evaluated. With lip-reading and captioning, if the captioning was not synchronised with the visuals and the student was attempting to lip read simultaneously then it became increasingly difficult to follow. One of the key problems then was keeping up with the conversation accurately and in real-time. Students who use BSL interpreters (including Student 2) experienced delays related to the two-way translation process so often missed the opportunity to contribute as the session had moved on.

Returning to the accuracy of the interpretation/captioning/assistance this was also problematic in that there was little interaction between the interpreter/captioner/assistant and the tutor or other students. In the examples given in the interviews the other attendees did not have access to that translation service which was provided independently.

Similarly, the practice of putting captioning into a different window to the main activity necessitating the need to continually switch attention between different screens was highlighted as “tiring” and “confusing” and again leads to either attendance as a passive observer or opting out of the session.

Screen reading raised additional problems relating to chat panes being read, problematic materials (slides, diagrams), live screen actions such as whiteboards and drawings being unreadable, and the screen reader talking over other contributors. Time constraints continued to raise problems with delays in identifying screen parts or getting focus, problems reading or identifying icons and popups appearing and the fact that magnification cannot view the whole screen simultaneously so it is difficult to ‘scan’.

From the staff interviews it was suggested that a transcriber can describe activities/slides as well as present commentary, but that whilst they can summarise voice conversations and key points it is often not everything and may not be enough. The academic re-iterated that whilst transcription can be useful for recall on recordings, and may mean that the student is not required to declare their disabilities, delays could certainly be an issue for timely interactions, the transcriber may not be a field specialist and nuances are lost as well as content in conversations, particularly those involving multiple participants. However, as the staff tutor highlighted, there are some very skilled and knowledgeable transcribers, but current automatic live captioning software often falters in specialist educational areas.

5.4.7 Summary – Interviews (P1S2, P2S3)

The survey identified a number of areas of interest that warranted further exploration, in particular interpretation, captioning, screen reading and reasons for opting out of the collaborative process. The student interview phase allowed these areas to be explored, probed, and clarified. In addition, the interviews with students provided richer detail on the nature, frequency, and consistency of barriers highlighting why they were specific to sensory impaired students, but also started to identify potential ways of addressing these barriers, building on the experiences of the students (both good and bad), explanations and assessment of the support they received, and suggestions as to how sessions could be improved to provide more support to address these barriers. These student interviews helped both to clarify some of the barriers identified in the survey and to begin to identify potential interventions in answer to RQ3.

The findings of the student interviews are summarised as follows:

There were frustrations as to the level of support on offer and the complexity of the process for getting adjustments. Dissemination of both student requirements and the processes and services available seem to present problems both from the student perspective – being made aware of what services the institution offered, and the processes to put them in place, and the staff perspective being unaware of what could be provided to students and how they could access these resources, and how they were used. Whilst these were practical problems, not directly impacting a collaborative online session, they contributed to the student opting out rather than negotiate access to the adjustments on offer.

Barriers relating to the provision of captioning for live sessions was problematic because of pacing, delay and synchronisation issues as well as the specialist language used in some modules. Similar issues arose with the use of interpreters.

With the body of knowledge established from the student perspective through survey and interviews, and the barriers emerging to answer RQ2, the staff interviews helped to provide institutional and staff perspectives on these barriers and to understand what interventions were currently available to students, how these were implemented, the constraints and complexities involved, how they were assessed and evaluated, and what might be added to the provisioning and learning design processes to improve inclusion. It also identified areas where gaps between institutional and student perspectives existed.

The findings of the staff interviews are summarised as follows:

Understanding how to make inclusive and accessible materials, particularly for science and maths modules, was a concern for academic, learning design and teaching staff.   As with the student interviews, staff expressed frustration with the complexity of processes, and dissemination of information, but also raised questions around the differences in approach between faculties. Recording of tutorials and provision of transcripts was a focus of discussion in both student and staff interviews. The time taken to produce transcripts reduced their usefulness, and these recordings were used by students in both tutorials and group work as a means of access to material required for subsequent sessions.

5.5 Focus groups - Workshop formats (P2S4)

5.5.1 Introduction

In order to get perspectives from as diverse a selection of staff members as possible a series of workshops were conducted targeting those involved in provisioning and supporting collaborative learning events. These allowed findings from student studies P1S1 and P1S2 to be explored from a different perspective. The sessions were run in different learning environments: as face-to-face sessions, online sessions, and combined sessions with face-to-face attendees on site and additional attendees online. Sessions were held both within and across faculties to determine whether there are different approaches, protocols, or criteria within faculties and schools, and to ascertain whether there are faculty specific activities or subjects which were more likely to raise problems (such as field work and experiments). Some sessions were conducted with combinations of stakeholders (academics, support staff, learning design team, researchers), faculty/school specific members, and others as tutor only sessions (see Table 69 Workshop Sessions) as tutors were the primary deliverers or facilitators or collaborative learning events.

Table 69 Workshop Sessions

Session	Format	Staff
Trial	Face-to-face	PhD students/IET staff
CALRG (Computer Assisted Learning Research Group)	Face-to-face	Open to all staff
AL Conference Scotland	Face-to-face	Associate Lecturers/Staff Tutors
Computing and Communication Group	Face-to-face and Online	STEM Staff
AL Online Conference	Online x 2 sessions	Associate Lecturers/Staff Tutors

The sessions were divided into a short introductory session delivered by the researcher followed by a collaborative group session. Finally, there was a reporting back and summation session. The introductory session commenced with a presentation from the researcher on the purpose of the research and the findings so far. These workshops were designed to encourage staff (and the researcher) to share experiences of tutoring students with sensory impairments and involving them in group work. Data from the student survey in the form or anonymised quotes was used as discussion material in the collaborative group sessions (see Figure 16). Personas were developed from combined and anonymised survey data to provoke discussion (see Figure 17).

Three short videos conveying the perspectives of students with sensory impairment were produced and played during the introduction to the sessions. These involved:

- A recording of a tutorial snippet with full sound and visuals
- The same snippet with distorted sound but full visuals
- The same snippet with a screen reader in use and distorted visuals.

As staff, particularly in the case of tutors, may not have been aware of some of the assistive technology tools in use, or of being lip read during a tutorial, particularly if the student is not part of their tutor group who you are more likely to have had some discussion with, these were used to provoke reaction and trigger discussions.

Slides were used during the presentation and distributed for discussion. These presented the aims and objectives of the sessions as:

- To highlight some of the barriers encountered by students with sight and/or hearing impairment when attending tutorials or joining in with group work
- Use the knowledge and experience of staff to contribute to our collective understanding of how to reduce the barriers to inclusion for these students
- To build up a framework of good practice
- To learn from the experiences of others
- To share ideas.

The sessions covered the student-identified barriers and available provisioning and adjustments for supporting students. In later workshops feedback and suggestions from previous workshops were also incorporated so that they could be built on.

5.5.2 Personas and Quotes

Several differently themed pages of student quotes (Figure 16) were used. In the face-to-face session these were printed on large sheets and placed in the middle of tables so that they could be read from different seated positions and rotated to allow participants to read simultaneously.

Figure 16 Sample quotes (1 of 6 produced) used in face-to-face workshops

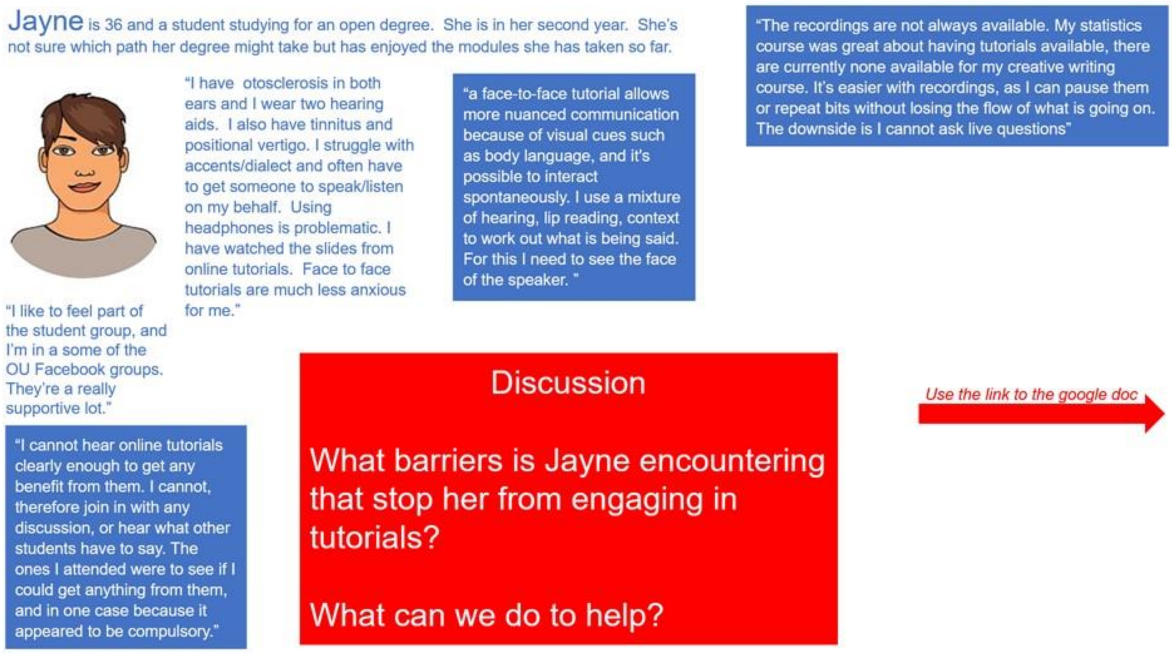
The attendees were asked to identify what barriers were being encountered by the students and possible ways in which they could reduce these barriers. They were encouraged to share experiences and practices around working with sensory impaired students in the past.

Anonymised personas were developed from the survey data to produce four personas:

- Jayne, a second-year Open Degree student who has hearing loss and tinnitus
- John, a biology student who is partially sighted and uses a screen reader
- Carla, a fourth-year part-time law student with hearing loss
- Frederick, a retired gardener with hearing and sight loss who is studying for an Open Degree.

All material used to create the personas came directly from the student data collected from the survey. All quotes were verbatim student quotes.

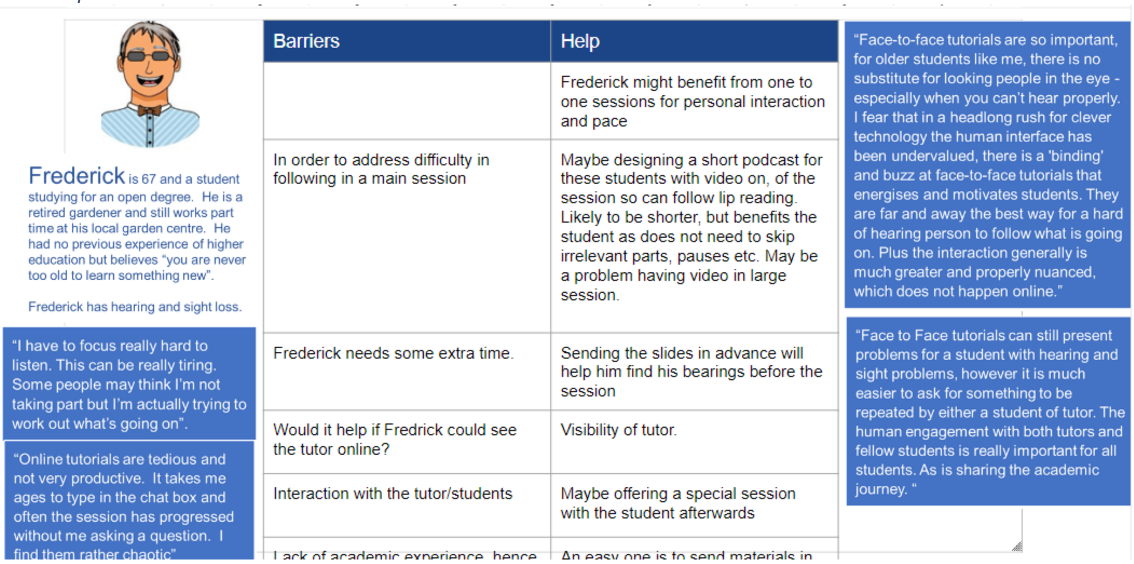
Figure 17 Sample Persona - Jayne



5.5.3 Analysis

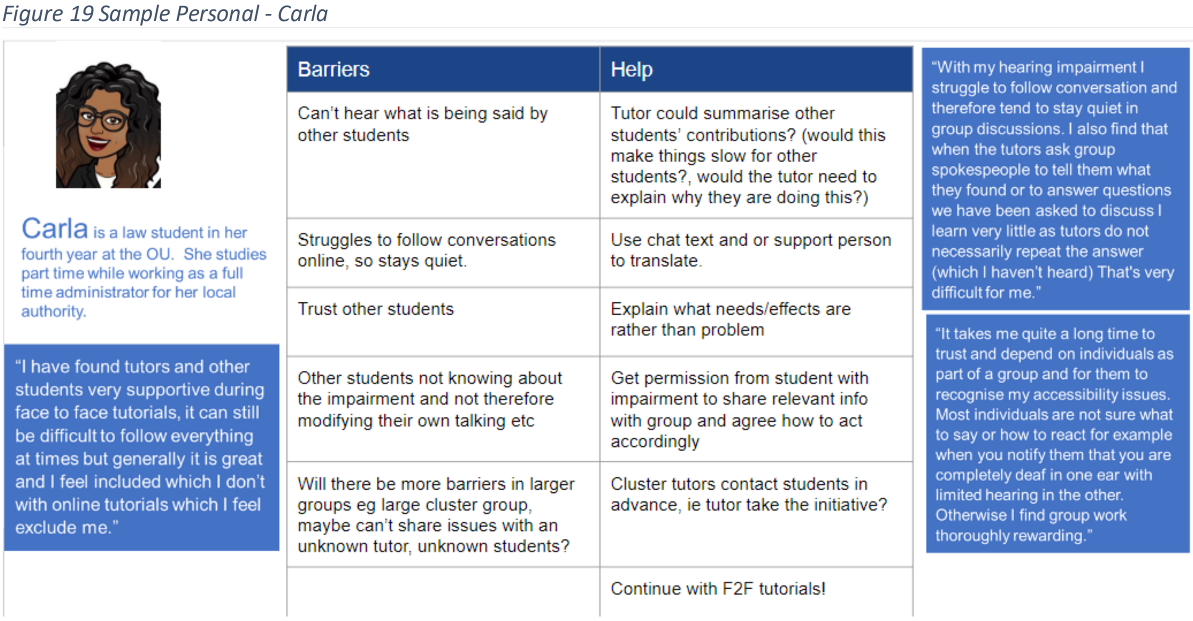
Contemporaneous notes were taken during the workshops and participants were asked work in small groups, each taking a different persona, and to fill in a form (paper or google format depending on the context) during their smaller group discussions utilising the personas. These were then shared with the whole group and barriers and potential interventions summarised collectively.

Figure 18 Sample Persona - Frederick



Barriers	Help
	Frederick might benefit from one to one sessions for personal interaction and pace
In order to address difficulty in following in a main session	Maybe designing a short podcast for these students with video on, of the session so can follow lip reading. Likely to be shorter, but benefits the student as does not need to skip irrelevant parts, pauses etc. May be a problem having video in large session.
Frederick needs some extra time.	Sending the slides in advance will help him find his bearings before the session
Would it help if Fredrick could see the tutor online?	Visibility of tutor.
Interaction with the tutor/students	Maybe offering a special session with the student afterwards
Lack of academic experience, hence	An easy one is to send materials in

Figure 19 Sample Personal - Carla



Barriers	Help
Can't hear what is being said by other students	Tutor could summarise other students' contributions? (would this make things slow for other students?, would the tutor need to explain why they are doing this?)
Struggles to follow conversations online, so stays quiet.	Use chat text and or support person to translate.
Trust other students	Explain what needs/effects are rather than problem
Other students not knowing about the impairment and not therefore modifying their own talking etc	Get permission from student with impairment to share relevant info with group and agree how to act accordingly
Will there be more barriers in larger groups eg large cluster group, maybe can't share issues with an unknown tutor, unknown students?	Cluster tutors contact students in advance, ie tutor take the initiative?
	Continue with F2F tutorials!

Some general feedback on provisioning highlighted the fact that we provide 1-2-1 support sessions for students as an alternative to tutorials but as this pulls them out of the student group and does not allow them to participate in group activities or student conversations it is really not ideal in this instance, and we are potentially isolating the student further.

The following potential interventions were identified through the workshop process, and discussion of what minor adjustments might have a bigger impact on the overall accessibility of tutorials and group work.

Pacing tutorials

The importance of pacing tutorials was discussed. Tutors felt that in online sessions, which were often limited to one or two hours, there was a lot they were expected to cover. There was a general consensus that in face-to-face situations (which were usually longer sessions), it was easier to keep to a slower pace.

In reaction to the feedback from the survey of the problems with pacing and timing there was acknowledgement that this is something that needs to be thought about and the urge to move rapidly on needs to be curbed. Suggestions included using anonymous signals from students to slow down/speed up rather than the current emoji options which indicated which student had requested that the session slow down. Some discussion on possible ways to implement this was undertaken in one session.

Leaving thinking and reaction time

The importance of thinking and reaction time was raised with participants talking about the problem judging how long to leave and acknowledging that they had not thought how it might be harder for some students than others to follow the lines of discussion and tutorial flow. There was talk about the fact that online any gaps in the conversation or presentation could often be seen as “awkward online silences” which led to them feeling an “urge to carry on speaking”. Tutors talked about how in face-to-face scenarios it is easier to judge when discussions are reaching a natural break or end, and to observe and listen in in a non-invasive way. In online sessions it was acknowledged that this is much harder as there are no clues as to whether the students are thinking or working on a problem or discussion point or just waiting for the tutor to continue, particularly as webcams are generally not in use. When breakout rooms were used for group work the tutors talked about moving between rooms but feeling that their presence was noted and perhaps impacted the discussion, or that the students felt they then needed to involve and refer to the tutor in their discussions when they appeared in the room rather than carry on working within their peer group. Some breakout rooms would be livelier that others (much as in face-to-face scenarios) but gauging when to move the sessions on, and where natural break points occurred, was perceived as much harder online.

Controlling participation

Again, many participants in the workshops had not appreciated the problems of multiple simultaneous speakers and the problems with distinguishing voices and identifying different speakers as well as managing chat communications simultaneously. Discussion revolved around the need for facilitation in conversations and to control and have protocols for determining who speaks when, ensuring that all students have an opportunity to contribute if they want to but managing who speaks when. There was a feeling that this was not always an easy process. Often the same students lead conversations and maintaining interest and enthusiasm for the discussion whilst restricting who speaks and when is a difficult balance to maintain. Some participants indicated that perhaps different, more relaxed, levels of control were required in breakout rooms than in the main tutorial room when the tutor/presenter would have a controlling role. The key concept was to encourage and support a controlled two-way conversation with the students

Providing materials in advance

The importance of providing materials in advance was discussed. Several workshop participants commented that they were reluctant to provide slides in advance as they often had answers or suggestions that they only wanted to reveal during a session, after the question or subject had been discussed and considered. There was also a feeling that students might choose not to attend if they could just pick up the slides. This also led to discussions around the quantity of information contained in presentations and whether these should or should not be consumable as standalone learning materials, or whether they should just provide supplementary or starting points for the tutorial material.

Describing slides as part of the narrative

Many workshop participants were unaware of the problems encountered by students in consuming slides utilised in a tutorial. Including slide descriptions and slide numbers as part of the tutorial narrative was posited as a way to make slides more accessible for BVI students when they were not screen readable (or indeed visible) within the session. Similarly adding notation for DHH students could help clarify content. If slides had been made available to students in advance in different or accessible formats, then indicating which slide is visible when in the session so that the student can follow was suggested to make access more viable. Suggestions were that these should be simple and clear statements rather than detailed descriptions. This might be simply stating the slide number on each presentation progression, or indicating which area of the screen is being referred to (e.g. "starting in the top left of the slide you can see… and the element in the middle at the bottom of the slide shows…"). This could help with both screen readers and those using magnification.

Live transcription of salient points

For DHH students struggling with following aural conversations and in the absence of live transcription services it was suggested that perhaps keeping a notes pane open and adding key points into it during the session might be helpful. This might help students follow the discussion better and encourage them to contribute and respond to statements.

Designing activities with accessibility in mind

There was discussion around activities such as ice breakers which had not been considered for accessibility, and the fact that rather than encourage participation these might have the reverse effect for BVI/DHH students if they felt excluded from the activity.

This led to much discussion about how to make activities accessible and what factors might make activities inaccessible. Suggestions included training for staff in accessibility, and trialling activities with disabled students, perhaps in collaboration with the Disabled Students' Group at the University.

Choosing colour schemes/font sizes

With the large number of students commenting on problems with font and colour combinations the importance of using large fonts, good font/background contrast, and colour choice with consideration of colour blindness was posited.

Avoid rearranging the group screen layout during a session

Again, workshop participants were generally unaware of how rearranging screen layouts during a session can have a negative impact on students and impact their ability to follow. Discussions around customising layouts talked about the fact that within Adobe Connect the layouts are under the control of the host/presenter so that students have little control over some aspects of the layout and are not able to customise it themselves. This increased the necessity for the host/presenter to be aware of accessibility when choosing and managing screen layouts.

Think about use of content – especially images and icons

There was lot of discussion around content in tutorials and group sessions, the problems with using whiteboards, specific problems with maths and formulae. The importance of providing descriptive text with images was highlighted, and the nuances of describing formulae accurately. A question was raised about how to 'translate' formulae for BVI students which is an area that requires some research.

Pre-empt problems by asking student what adjustments they need

The importance of reading student profiles before a session was highlighted. These provide both generic and specific suggestions as to how to support individual students. As referenced in P1S1, the student's own tutor will normally be familiar with students' requirements and will hopefully have negotiated with the students themselves as to how to support them, but this is not always possible with students from other tutor groups attending a specific tutorial. Only when a student signs up in advance of a session will their profiles be available. This means that tutors are likely to miss late sign-up details and therefore be unaware of requirements. However, the general consensus was that these profiles should be read, and contact made with students prior to an activity to negotiate what help can be provided.

It also became apparent during the workshops that tutors were not aware of the University services in terms of BSL interpreters and live captioners and the processes students needed to undertake to secure these services.

Assistive Technologies

There was a concern about the general lack of knowledge or understanding about the nature and use of assistive technologies and surprise at the extent to which these were being used. The fact that "we have very little understanding of what students are doing during the tutorials" was raised and the difficulty of appreciating how this might impact their ability to engage. The lack of understanding of assistive technologies was discussed in the more general context of the complexity of running distance sessions, when students might be working in public places, on the move, at work, whilst juggling childcare, or other distractions, and that assistive technologies added another aspect to this that they were unaware of. Again, the suggestion was that training was required for staff in understanding what these technologies are, how they work, and how to design materials and activities that support their usage. In one of the non-tutor events, feedback suggested that use of screen readers was more widespread than perhaps people were aware of with usage by not only BVI students but those with other disabilities that impacted their ability to read and consume materials quickly such as dyslexia, and mental health conditions. This was supported by the data obtained from the academic interviewee in P2S3.

Use a webcam

The use of webcams during tutorials generated a lot of discussion. Many tutors did not want to be seen on camera when working from their homes and there was talk of being self-conscious about their use. There were acknowledged technical problems with their use relating to bandwidth problems with the learning platform meaning it was not viable to use webcams in tutorials. The large size of some tutorial groups also restricted this as an option for all participants.

One thing that emerged from both the staff workshops and the student questionnaires was that whilst most tutors were committed to making sessions and activities accessible, they were not aware of how to do so, and the adjustments required. There was a lot of anxiety from students about switching between tutors too.

5.5.4 Mapping to Model

At the end of P2S4 a full re-analysis of the data was performed so that a framework could be presented to the Collaborative Design Focus Group for P3S5. This followed a similar process to that at the end of P2S3 whereby the finding from the workshops were added to NVivo and all content re-coded and adjusted to better represent the combined data set. Code at the end of P2S4 was compared with those at the end of P2S3.

The mapping of the codes is provided in figures below.

Online Chat, Transcripts and Captions, and **Text** were merged into a single code in Communications, ***Text Communications***. Two new codes were created in Communications: ***Visual*** Communications and ***Mode Control*** which included some codes re-allocated from Learning Platform (AC). Visual communications covered all visible components of the session so included webcam streams, shared materials, whiteboard, images, slides, and shared screen content. This was included to provide specific reference to visual components but not restricted to their screen readability or navigability.

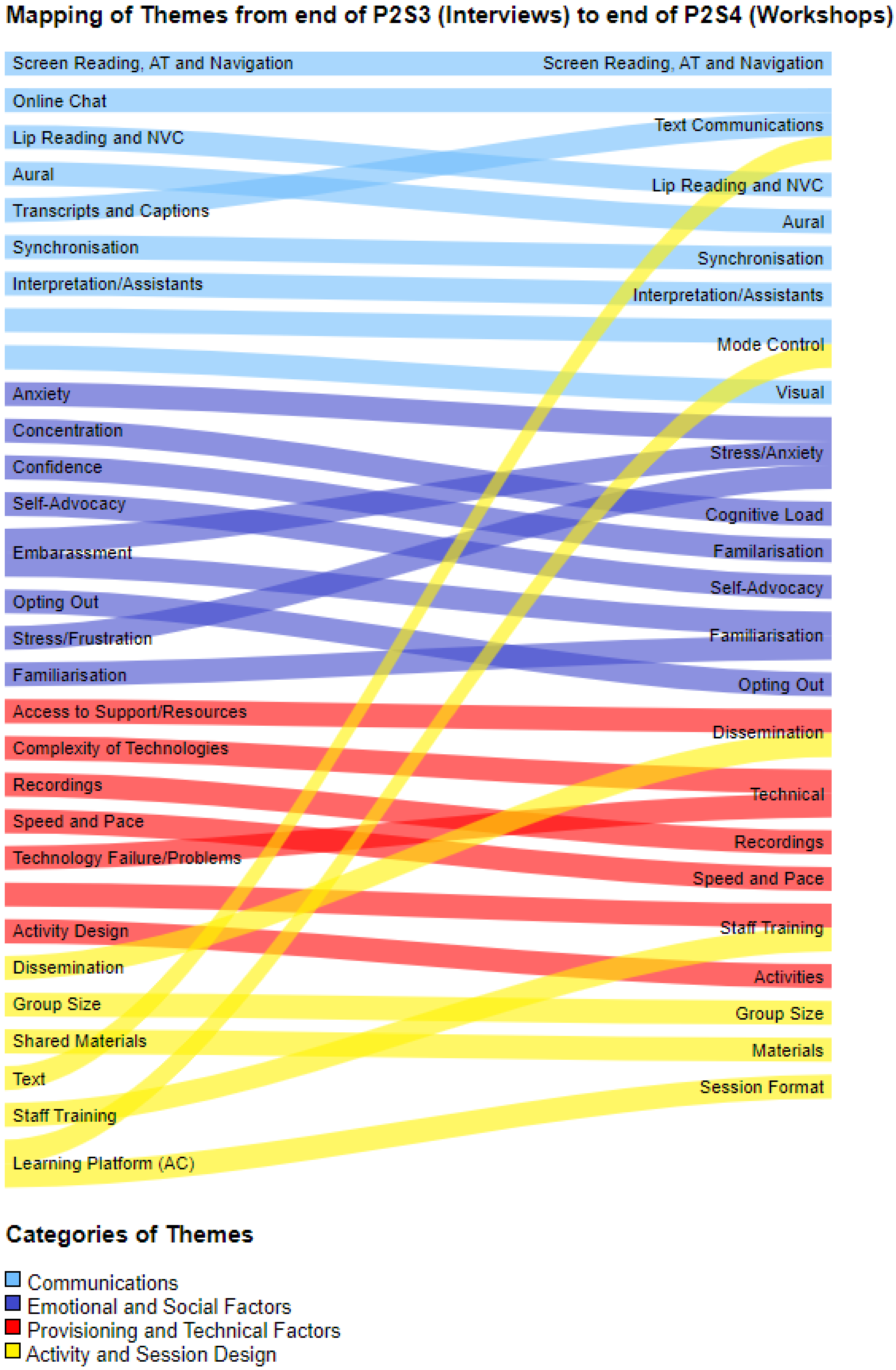
Anxiety, Embarrassment, and Stress/Frustration became a single theme, ***Stress/Anxiety***. A new theme of ***Cognitive Load*** was added which incorporated many of the codes from the ***Concentration*** theme. It became apparent from all three of the studies that the cognitive load placed on SI students in engaging in an online environment was significantly higher than that of other students. The process of consuming and responding to communications and content was more complex, required greater concentration and focus, often leading to fatigue and passive rather than active participation. ***Confidence*** was merged into the ***Familiarisation*** theme, which also incorporated some of the ***Embarrassment*** codes. Much of the lack of confidence seemed to arise from the 'unknown', particularly not knowing how their disabilities would be handled.

Dissemination was reallocated to the Technical and Provisioning category and ***Access to Support/Resources*** was reallocated to ***Dissemination***. Reviewing the problems with access to support and resources, and with the additional benefit of the staff perspectives being added, it became apparent that the main problems were with not knowing or having to hand the information needed and disability declarations and adjustments not being disseminated.

Complexity of Technologies and ***Technology Failure/Problems*** were merged into a single theme of ***Technical*** factors. ***Staff Training*** was reallocated from the Activity and Session Design category to Provisioning and technical as this was seen as more of a provisioning issue. Some aspects of the ***Learning Platform*** were merged into ***Mode Control*** which was about enabling students to have control over their learning environment.

The mapping of themes from the end of the interviews (P2S3) to the end of the workshops is shown in Figure 20 Theme Changes #2.

Figure 20 Theme Changes #2



5.5.5 Summary – Focus Groups – Workshop Format (P2S4)

The format of staff workshops allowed the findings of phases 1 and 2 of the research to be discussed and debated so that this knowledge could be built upon to continue to address RQ3 by identifying possible interventions to address the barriers and improve inclusion. This allows sharing of experiences and practice from a wide variety of staff directly involved in the provisioning of synchronous online learning, primarily the tutors, but also including management and module teams, student support staff and learning design specialists. The use of materials and artefacts developed from P1S1 and P1S2 allowed participants to focus on the barriers identified in response to RQ2 and build on the body of knowledge from the staff interviews in P2S3.

Each workshop utilised findings from previous workshops as well as those from previous studies so that knowledge continued to be both accumulated and disseminated. This iterative process, and the inclusion of different staff roles, faculties, and workshop formats, enabled lessons to be learned and passed on to subsequent sessions. This included refining of both the findings, and the design and running of the sessions. As additional findings were incorporated into the artefacts and stimuli for discussions in subsequent workshops the clarity and strength of the findings grew and the evidence to support the validity of the barriers and the effectiveness of the interventions could be assessed.

There was a willingness of staff to acknowledge that they did not always know how to address barriers to engagement and were unaware of the barriers encountered by students – particularly in the use of assistive technologies. Staff were unaware of the use of screen readers, and shared material was not always screen readable – particularly live whiteboard activities and shared artefacts. There was a commitment by staff to try and address and acknowledge these barriers.

5.6 Focus Group - Collaborative Design (P3S5)

5.6.1 Introduction

The collaborative design focus group operated over two months in 2020 and operated online due to the limitations presented by the pandemic. This format, however, enabled the research group to work within the context of the research i.e. in an online synchronous collaborative environment. The primary aim of the focus group was to design a framework in the form of a model to illustrate the barriers to collaborative learning for BVI and DHH students and to suggest interventions to help to address these barriers. The output of the collaborative design process was a framework conceptualised as model presented as an interactive website called MACE (model of accessible collaborative engagement), the prototype for which is available online at http://jobuxton.online/ The elements and functionality of this model are discussed in in the Model chapter. The model illustrates the areas where barriers to engagement might occur (RQ2) and makes suggestions as to possible interventions to help reduce these barriers (RQ3), with the aim of improving inclusion in online synchronous collaborative learning for SI students (RQ1).

This framework was built by the focus group and researcher from the findings of phases 1 and 2 of the research. The barriers and interventions identified through the content and thematic analysis of the data and the outcomes of the workshops were presented to the group in the form of accessible shared documents on the online collaborative platform. Subsequent to the initial introduction sessions with the group members four live meetings of the focus group took place in Teams. At each session specific aspects of the model were discussed, developed and refined. Between these live sessions the model was refined based on feedback and presented and agreed at the following meeting. Between sessions forum discussions were implemented and additional materials shared.

This meant that the model was developed through collaborative working:

- Online in a live synchronous environment
- Online in an asynchronous forum environment
- Online via asynchronous wikis and related content
- Through shared collaborative materials
- Through individual email contributions and suggestions.

There was also an anonymous forum available for contributions (which was not used but had been made available for participants who might want to submit feedback anonymously to the project).

5.6.2 Focus Group Members

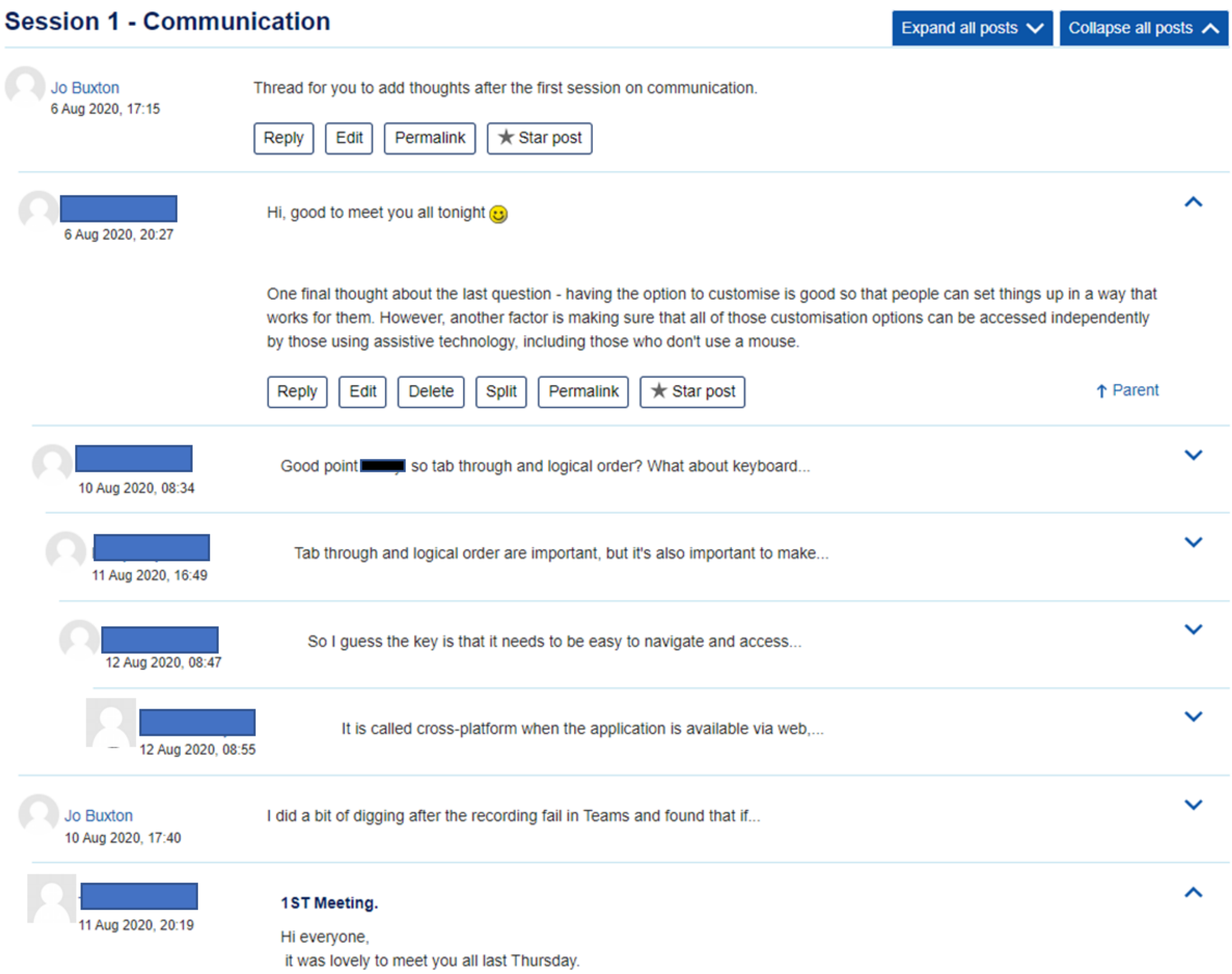
There were 10 members of the focus group which included:

- DHH/BVI representative selection
- 8 women and 2 men
- 3 Staff, 6 Students and one who was both a staff member and a student.
- Facilitators: two PhD students facilitated during the live online sessions

5.6.3 Asynchronous Collaboration

The majority of decisions relating to the construction of the model that were made using an asynchronous collaborative environment were made via the forums a sample snapshot of which is shown in Figure 21. These allowed continuation of discussion from the synchronous meetings in a time independent format. The contributions in this format varied from those in the live sessions in that they were often more contemplative, and showed that ideas raised in the live sessions had been independently progressed with different participants allowing them to reflect and report back on their thoughts. These allow additional conversations to take place without time restrictions.

Figure 21 Screenshot of Part of Session 1 - Communication Forum



Between the sessions and just prior to a scheduled meeting the content of these asynchronous communications was implemented allowing:

- Analysis of forum discussions
- Analysis of email communications
- Analysis of shared materials
- Analysis of participant-initiated forum discussions.

The Moodle site also included a wiki (which was not extensively used) and an Open Studio Space to share objects and resources (see Figure 22 and Figure 23).

Figure 22 Focus Group Area on Moodle Site

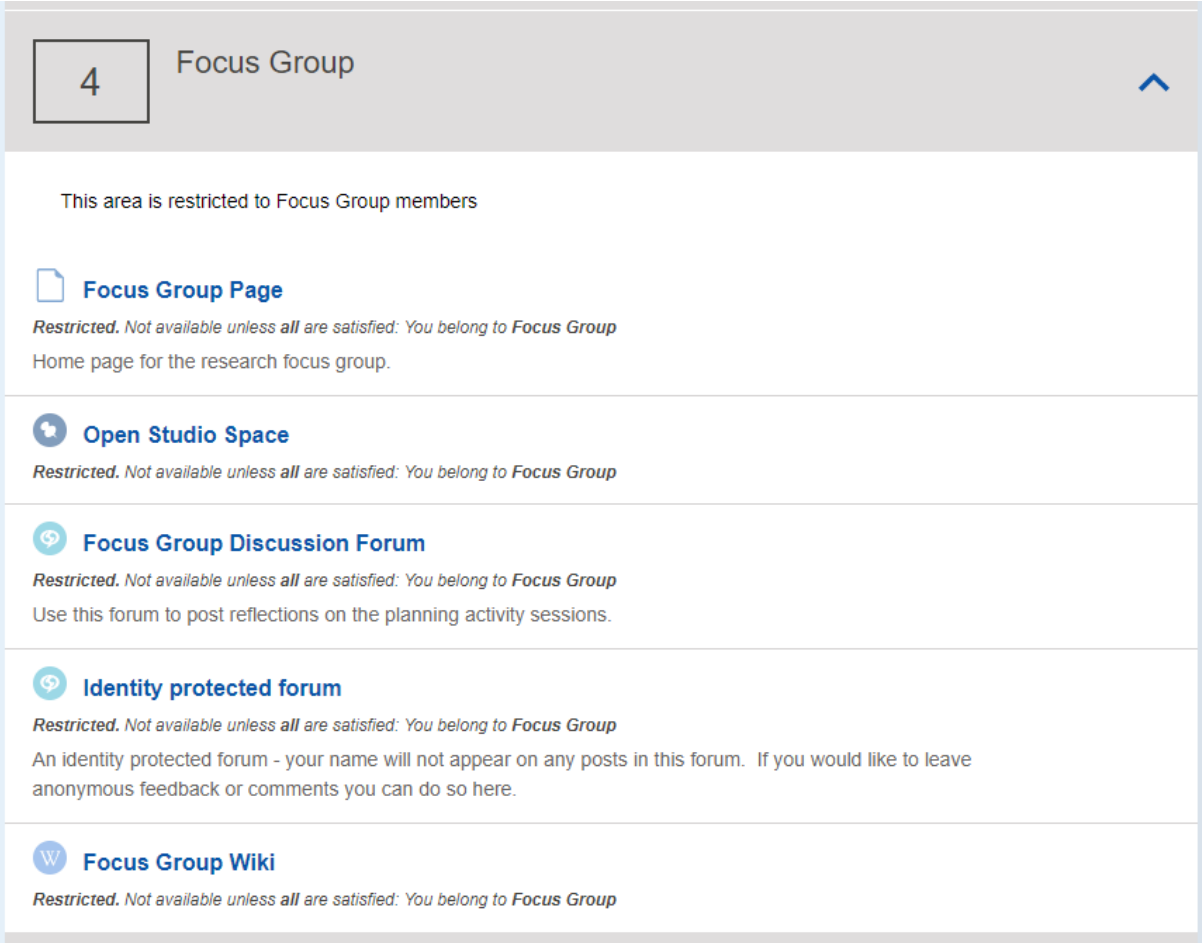
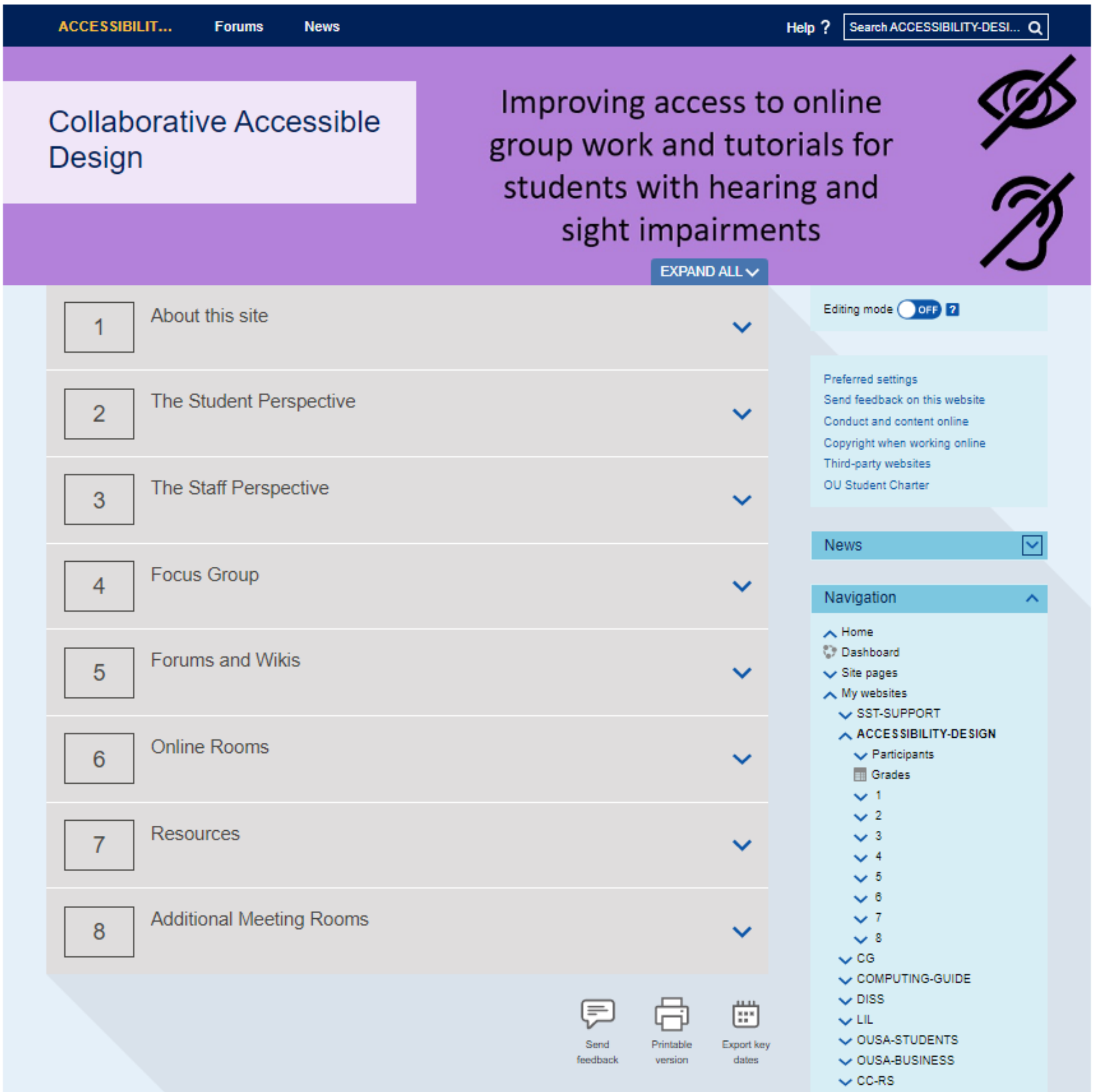


Figure 23 Moodle Site



5.6.4 Synchronous Collaboration

The synchronous sessions provided the main focus for the group.

Pre-Group Familiarisation Sessions

A focus group channel on Microsoft Teams was set up for the research via the Open University which had restricted access so that only focus group members, facilitators, and research supervisors had access to the channel. Participants were required to use their OU accounts and the Team App to access all the facilities required (such as captioning). All participants were contacted by email prior to the session with a word document (accessibility checked) to indicate how to access the Teams Channel and the email suggested a pre-focus group familiarisation session.

Six of the participants elected to have these familiarisation sessions, those that did not were asked to drop into Teams and leave a note to indicate that they had successfully accessed the channel and were happy to use it. Prior to the first focus-group meeting all members had access to the channel to explore further in their own time.

During the familiarisation sessions participants were asked to explore the different means of communications such as text, voice, webcam, emojis, and reaction, and to generally familiarise themselves with the environment so that they could perform functions such as turning live captioning on or off, pinning speakers, and changing layouts. In the familiarisation session with a participant using screen reading software the researcher simultaneous used her own NVDA software to explain and explore the screen with the participant.

The forums were also open and available prior to the first live session so that participants had an opportunity to introduce themselves asynchronously to the other members of the group prior to the live sessions and a link was provided to the 'introductions' forum by email.

Prior to the first session documentation was sent to participants explaining what to expect in the live sessions, including the materials that would be shared that presented the findings of the research so far and the areas and questions to be explored during the session.

This process was intended to explore and reflect on the identified barriers relating to familiarisation with the intention of reducing related anxiety. These were reflected on and discussed in session 2 and the findings are presented there.

There were four synchronous online sessions held in Microsoft Teams. Each lasted approximately 1.5 hours. During the session contemporaneous notes were taken by hand by the researcher which were then written up immediately following the session. Between the sessions the findings were fed back into the model. The structure of each session, goals and objectives, and findings are presented below.

Session 1 – Introduction and Communication

The aims and objectives for the first session were:

- Make introductions and establish that communications and participation were possible for all
- Discuss and collectively agree on grounds rules, terminology, and personal preferences
- Introduce the research projects and findings so far
- Set out the objectives for the focus group

- Introduce the model of engagement.

The participants were then asked to focus on communication issues for the session, so the final objective was to:

- Explore problems relating to modes of communication and discuss possible interventions to improve access.

At the end of session 1 the findings were applied to the model which was then published on the Moodle site. The Session 1 discussion thread was started on the forum for participants to use between the sessions. This process was repeated after each session.

Session 2 - Emotional and Social Factors

The aims and objectives for the second session were to explore emotional and social factors:

- Problems relating to anxiety and stress and discuss possible interventions to reduce these.
- Problems relating to disengagement and opting out and discuss possible interventions to encourage participation

and to discuss:

- The need for self-advocacy and how this can be minimalised
- Topics in general but also with specific reference to sensory impairment.

The session started with feedback from Focus Group Session 1 and re-introduction of the model.

Session 3 – Provisioning and Technical/Activity and Session Design.

The aims and objectives for the third session were to explore session management and activity and material design:

- Management and design of online live sessions.
- Problems relating to session management and provisioning and discuss possible ways of handling them.
- Problems relating to activity design and structure.

Session 4 – The Model

This final sessions objectives were to review the model developed from sessions 1 to 3.

This model pulled together the interventions arising from the suggestions and feedback from each session and the forums.

In terms of interventions participants were asked:

- Are there any areas that you think the model does not cover?
- Do you think the model improves communication barriers?
- Do you think the model reduces emotional and social barriers?
- Do you think the model improves engagement?
- Do you think the model reduces the chances of students opting out?
- Do you think the model improves access in terms of provisioning and session management?
- Do you think the model reduces barriers in terms of activity and material design and session structure?
- How viable do you think the model is?
- How could we trial or implement it?

These questions were supplied in advance to allow participants to consider them.

5.6.5 Summary – Focus Groups – Collaborative Design (P3S5)

The findings of phases 1 to 4 of the research resulted in a prototype for the model of accessible collaborative engagement based on the themes established (barriers) and the interventions that might reduce these barriers. This final phase turned that prototype into a model. The focus group had representatives from both staff and students, and BVI and DHH participants. As they collaboratively designed the model in an iterative process over four synchronous online sessions in parallel with asynchronous collaborative tools, the different learning environments provided both context and content for the study. The process of intentionally utilising the components and context being examined for the research as the means and methods of performing that research enabled the model to have clarity and refinement. As a product of a group of DHH/BVI participants it also gave a voice to this community.

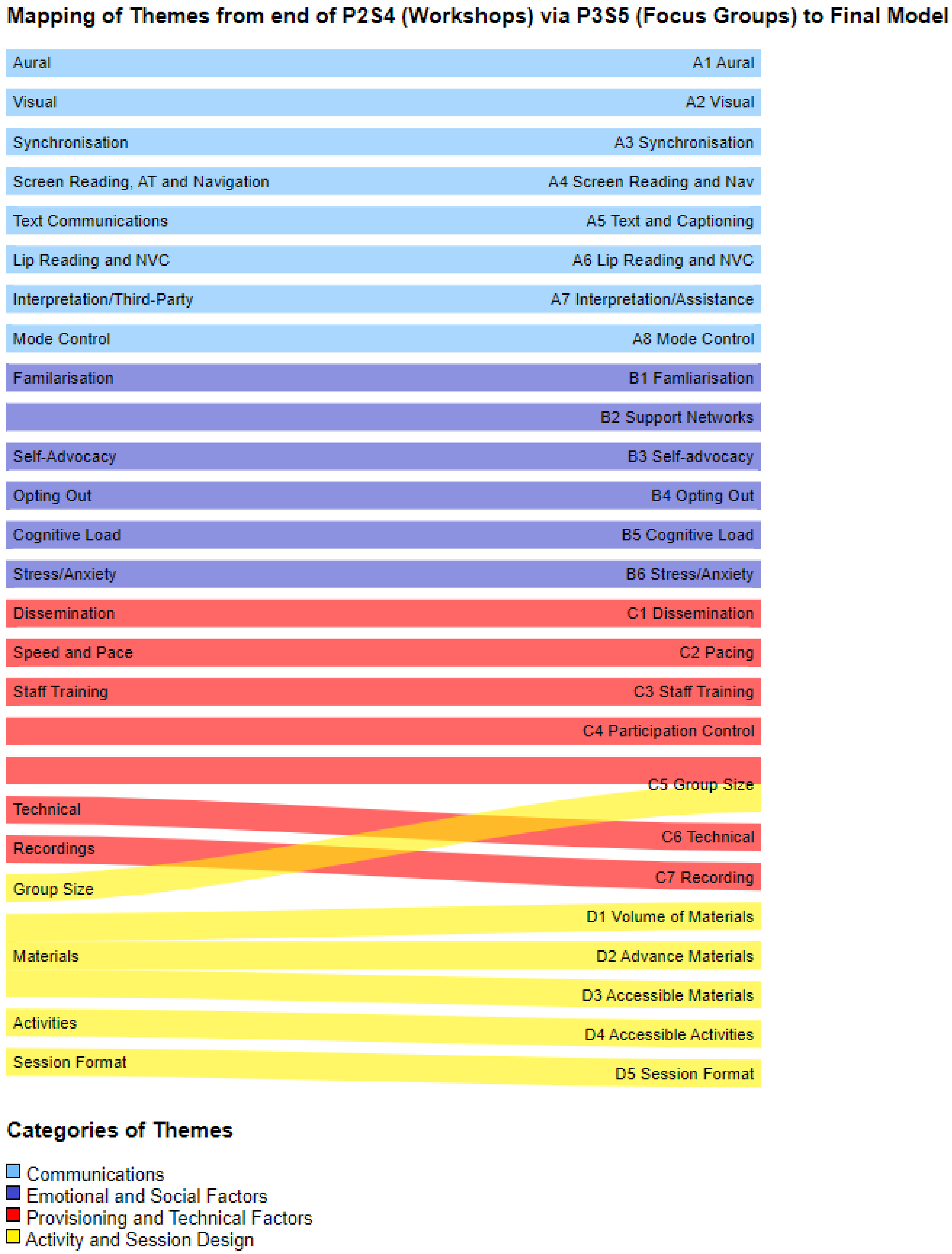
The findings of the focus group are covered in the Chapter 6 of this thesis.

5.6.6 Mapping to Model

The mapping of the themes at the end of P2S4 to the final model as determined by the focus group is provided below.

In the final mapping a new code in Emotional and Social Factors was created: ***Support Networks***. ***Group Size*** was reallocated from the Activity and Session Design category to Technical and Provisioning. Materials was split into three themes: ***Volume***, ***Advance***, and ***Accessible Materials***.

Figure 24 Mapping to Model



5.7 Findings Discussion

The series of studies and methods allowed a robust, supported model of collaborative learning to be designed that utilised the perspective of both staff and students. The development of this in line with DBR principles in an iterative process provided validation for the model.

The survey established that online synchronous collaborative sessions were causing barriers for DHH and BVI students. Involving the staff in the research through interviews and workshops highlighted the areas where both institution and staff were unaware of potential barriers and identified ways of beginning to address those barriers.

The work with the focus group enabled each barrier to be discussed in conjunction with potential interventions and through an iterative process of design and evaluation, produce a model that could be utilised by staff and students alike when organising online collaborative learning sessions.

In answer to the research questions:

- RQ1 How can we improve inclusivity in online collaborative learning for students with sensory impairments?

Yes, there is potential to improve inclusivity in online synchronous collaborative learning for students with sensory impairments by acknowledging the barriers that exist and by implementing the documented interventions

- RQ2 What are the barriers to engagement for students with sensory impairments?

Barriers exist in relation to the four main themes identified:

Communication modes:

> aural, visual, synchronisation, screen reading, captioning and text, lip-reading and non-verbal communications, interpretation and the control of communication methods.

Emotional and engagement factors:

> familiarisation with people, environment and activities, support networks, self-advocacy, disengagement and opting out, cognitive load, stress and anxiety.

Provisioning and technical factors:

> dissemination of information and good practice, pacing, staff training, participation control, group size, technical training, recording and transcripts.

Activity and session design:

volume of materials, advance provisioning of materials, accessible materials and activities, session format.

- RQ3 What interventions can we design that might improve inclusivity for sensory impaired students in online synchronous collaborative learning events?

The model provides a way to understand the barriers and suggest ways to address them in a learning environment.

Chapter 7, Discussions, reflects on the findings of this research, the importance of contributions and perspectives of the different studies and participant groups, and on the effectiveness of taking a design-based research approach to this project. The next chapter documents the model, the output of the Focus Group.

6 The Model of Accessible Collaborative Engagement (MACE)

The MACE framework has been visualised as an interactive website intended to enable participants in synchronous collaborative online learning sessions to understand how to approach inclusion for sensory impaired students in these sessions.

The model is available at http://jobuxton.online/. The process implemented for accessibility testing of the model is outlined in appendix (g).

This section provides the detail for the MACE framework that emerged from this research through collaborative design. This represents the text from the model and is therefore not intended to be read sequentially but accessed through navigating areas of interest via the interactive website. It is provided here to illustrate the content.

Using the model

The model was designed primarily for sensory impaired (SI) students, those who are Deaf or Hard of Hearing (DHH), those who are Blind or Visually Impaired (BVI), and those who have Dual Sensory Impairment. This covers a wide range of impairments, and each student has different personal attributes and characteristics that can impact their ability to join in with online live learning events and work with their tutors and peers. Developed collaboratively with SI students and production, support, and teaching staff at The Open University, the model looks at all aspects of the student experience and learning environment that might present barriers to their engagement with online live collaborative learning and through this holistic perspective presents ways that we can reduce these barriers.

The model visualises the 4 categories and 26 elements identified in the research into 4 pieces of a jigsaw. This jigsaw is a metaphor for successful collaborative engagement. When all the pieces are in place the image is complete and engagement is possible. Each element contributes to forming a piece. Any barriers to an element result in a malformed piece. In order to correct it interventions must take place. These interventions are twofold: addressing the barriers relating to that element and looking at what other elements might provide help.

The model pieces and factors are shown in Table 70. Each of the pieces and factors can be explored and are referred to alphabetically (A to D) for each piece and alphanumerically (A1-A5, B1-B6, C1-C7 and D1-D5) for each factor.

Table 70 Model Pieces and Factors

Piece		Factor	
A	Communication Modes	A1	Aural
		A2	Visual
		A3	Synchronisation
		A4	Screen Reading and Navigation
		A5	Captioning and Text Communications
		A6	Lip Reading and Non-Verbal Communications
		A7	Interpretation and Assistance
		A8	Mode Control
B	Emotional and Social Factors	B1	Familiarisation
		B2	Support Networks
		B3	Self-advocacy
		B4	Opting in/out
		B5	Cognitive Load
		B6	Stress and Anxiety
C	Provisioning and Technical Factors	C1	Dissemination
		C2	Pacing
		C3	Staff Training
		C4	Participation Control
		C5	Group Size
		C6	Technical
		C7	Recording
D	Activity and Session Design	D1	Volume of Materials
		D2	Advance Materials
		D3	Accessible Materials
		D4	Accessible Activities
		D5	Session Format

The home page provides an overview displaying the four pieces (Figure 25 MACE pieces). Selecting a piece displays the various factors.

Figure 25 MACE pieces

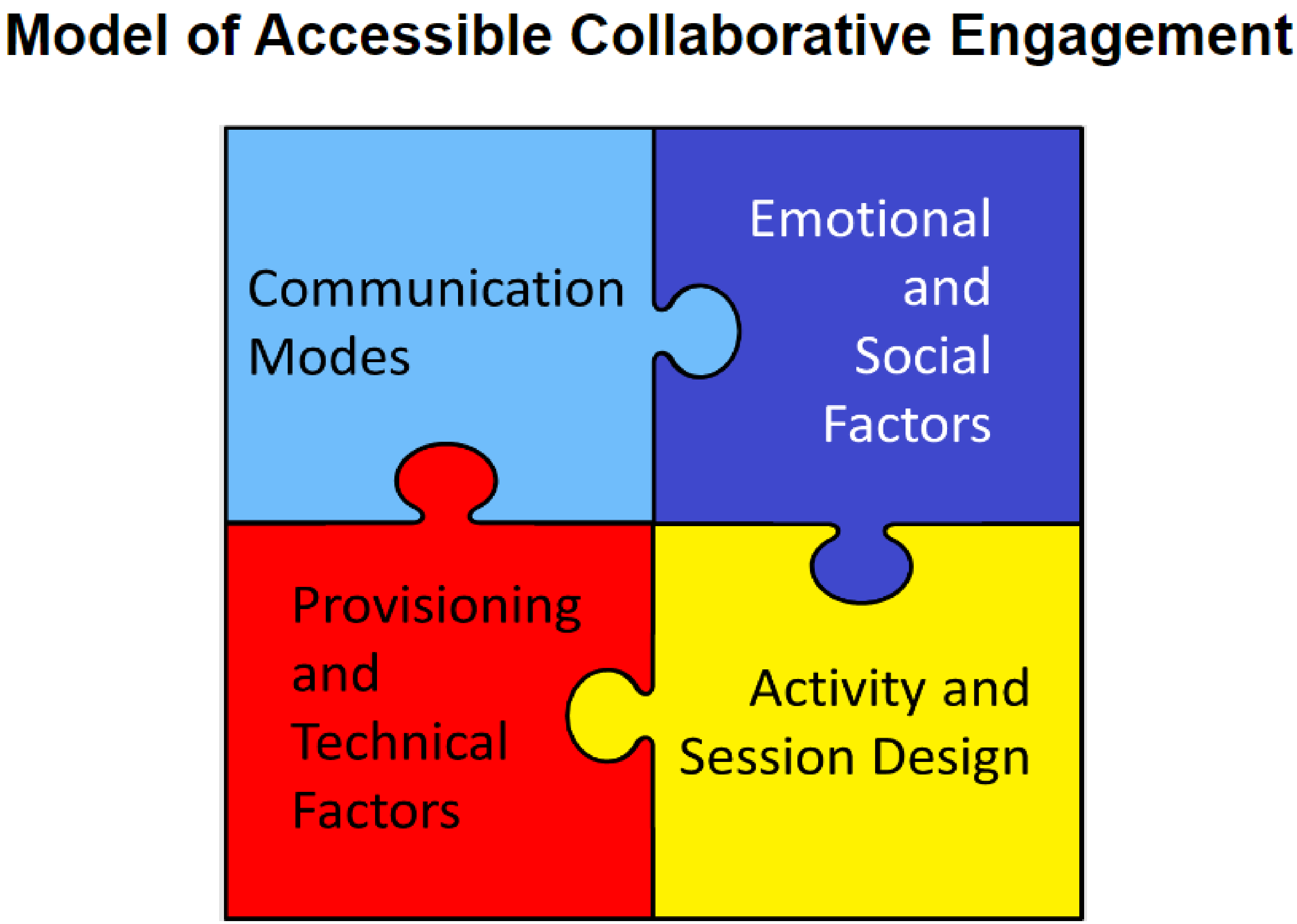
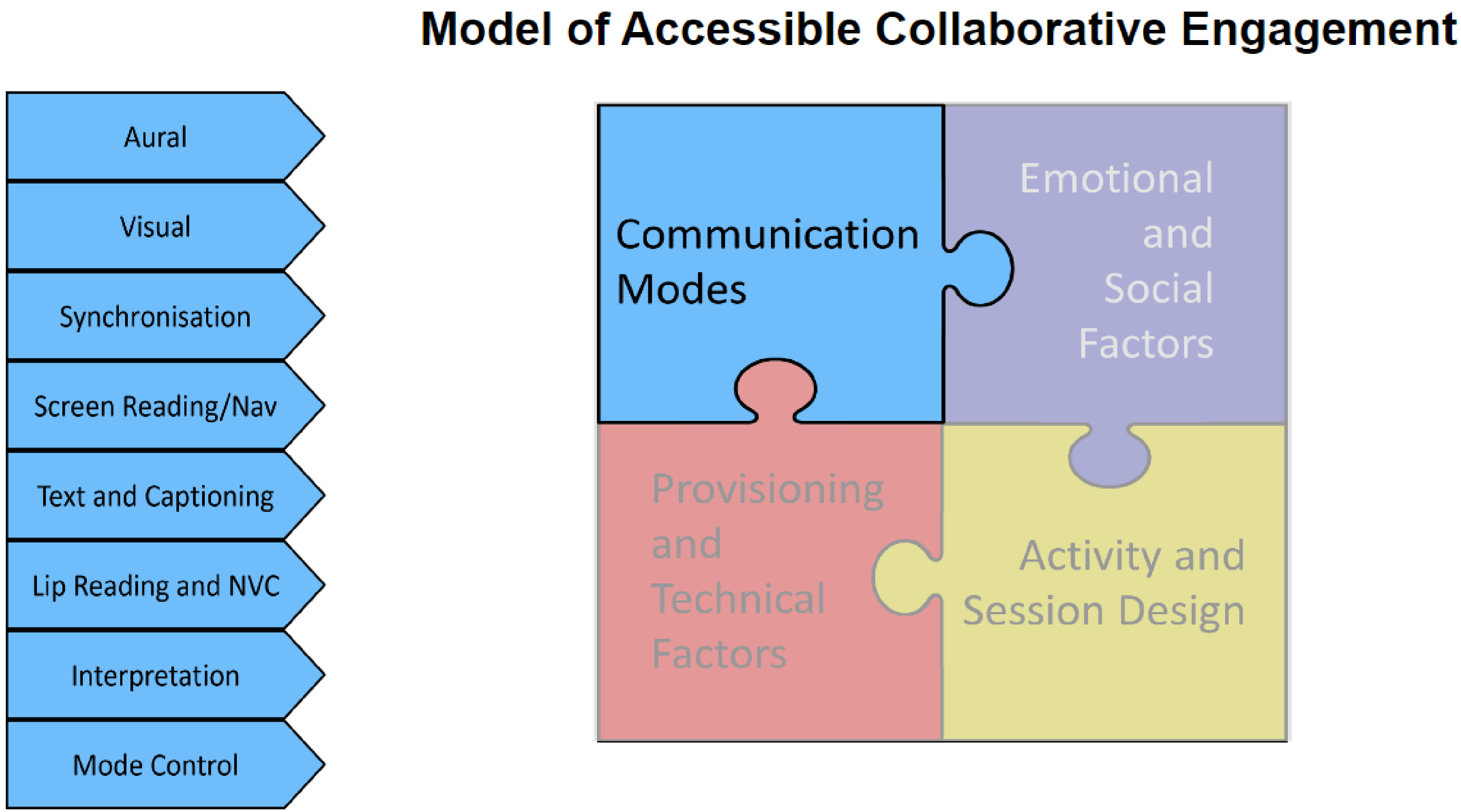
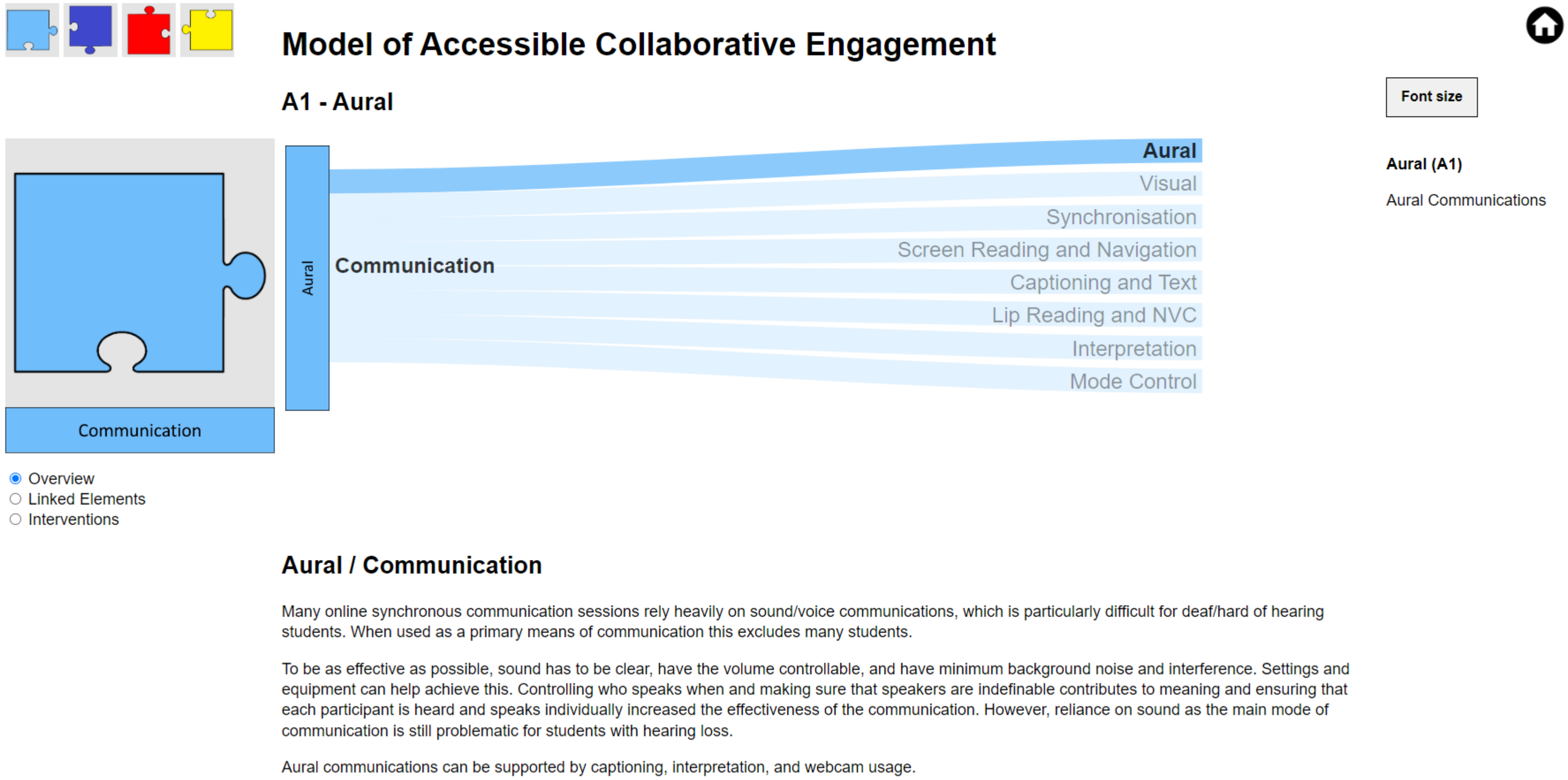


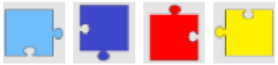
Figure 26 MACE Factors

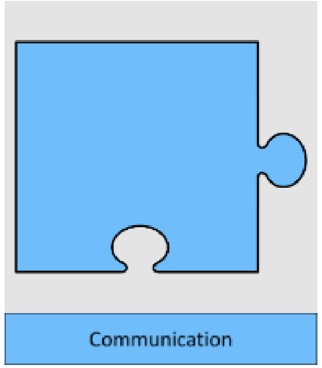


The model can be explored, and factors and interventions illustrated though the use of Sankey diagrams which show the various factors with their weighting (indicated by the width of the flow). Moving the mouse across the chart provides a brief description of each factor. Selecting a factor gives a more detailed overview of that factor. Once a factor is selected further details of the element are presented with their impact on other pieces (linked elements) and potential solutions to the barriers (interventions) proposed. These are accessible by selecting an element view. The whole model can be navigated by selecting an element or piece at any stage and the four pieces are accessible at the top left of the screen.



Select Piece

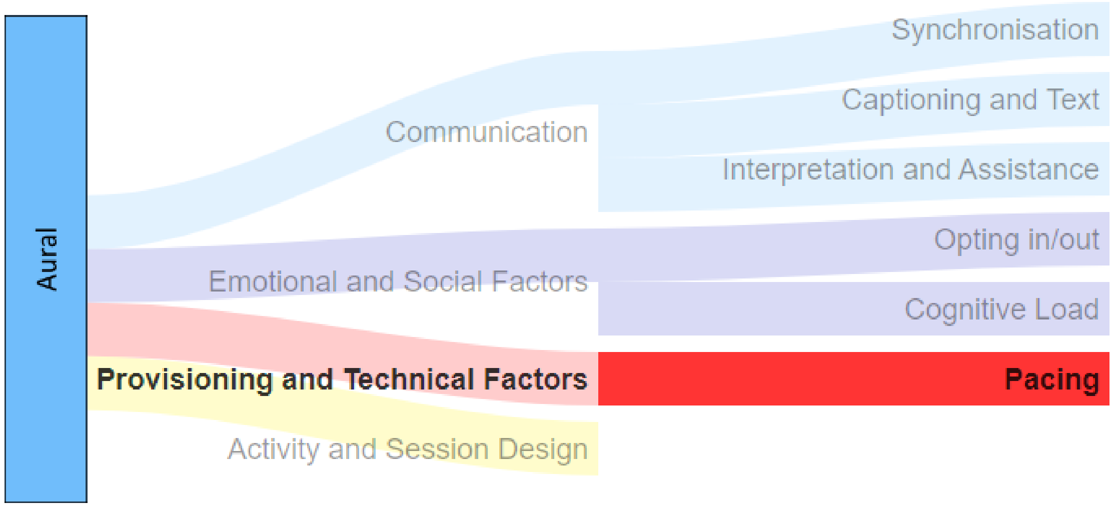




- Overview
- Linked Elements
- Interventions

Model of Accessible Collaborative Engagement

A1 - Aural



Elements linked to Aural / Communication

- **A3** Synchronisation
- **A5** Captioning and Text
- **A7** Interpretation and Assistance
- **B4** Opting in/out
- **B5** Cognitive Load
- **C2** Pacing

When a student's hearing is limited, and communications occur aurally then it can take time to make sense of that communication. This has an impact on both cognitive load (B5) and pacing of a session (C2) as a student scans for meaning or sense of the discussion before consuming or contributing to the conversation. Similarly, because of the difficultly following the conversation they are reticent to contribute themselves for fear of

A - Communication Modes

At the core of making online live collaborative learning accessible for sensory impaired students is enabling communication. Joining in with online collaborative activities requires effective communication between all participants. Collaborative learning is essentially about two or more people working together to complete a task or achieve a goal, sharing and exchanging ideas and knowledge. Online collaborative environments can offer lots of different means and modes of communication. As well as the core modes of aural and visual communications, communications can take place via text, lip reading, body language, and non-verbal communications, via third-party interpreters and assistants, or via the use of assistive technologies such as screen readers, voice to text, and magnification software.

You cannot effectively collaborate with others if you cannot communicate with them. When a student has limited access to one or more of these modes then the others have to be utilised effectively in order to compensate. Students often rely on a combination of communication modes in order to be able to make meaning, and to engage in synchronous collaborative learning. They also need to be able to control, access and manipulate these modes of communication, and the different modes have to be optimisable to provide the best support possible, be it making sure that interpretation or captioning is synchronised with other communications, or ensuring screen layout and content is navigable and readable.

A1 Aural

Description: Aural communications – sound and voice.

Overview

Many online synchronous collaborative sessions rely heavily on sound/voice communications. When used as a primary means of communication this excludes many students and is particularly difficult for DHH students. For BVI students this may be their primary means of communication, so quality and clarity of sound is important. Students with hearing loss often take longer to make meaning of aural communications as they need to construct meaning from the available clues. So, for all students sound quality needs to be clear, adjustable, have consistent volume, and minimum distortion.

It is useful to remember that a student using a screen reader will have an additional aural channel to consume – the voice of the screen reader – in addition to other participants voices and shared media.

However, reliance on sound as the main mode of communication is still problematic for students with hearing loss.   Aural communications can be supported by captioning, interpretation, and webcam usage which allows for lip reading, and reading of gesture, body language and facial expressions.

Linked Elements

A3, A5, A7, B4, B5, C2

When a student's hearing is limited, and communications occur aurally then it can take time to make sense of that communication. This has an impact on both cognitive load (B5) and pacing of a session (C2) as a student scans for meaning or sense of the discussion before consuming or contributing to the conversation. Similarly, because of the difficulty following the conversation they are reticent to contribute themselves for fear of misinterpreting a communication (B6) so often choose to opt out of the discussion (B4).   Students are often forced into self-advocacy or needing to declare disability within a group in order to make the participants aware of the barriers presented to them by aural communications.

Interventions

A2, A5, A6, A7, B5, C2, C3, C4, C6, D2

To be as effective as possible, aural communications have to be clear, with consistent controllable volume, and have minimum background noise and interference. Settings and equipment can help achieve this (C6) as well as staff training on effective use of microphones (C3).   Consistency of volume where centrally controllable via a learning platform can also improve accessibility, allowing minimal adjustments to hearing aids and receiving equipment during a session, which can otherwise be distracting and further contribute to the cognitive load (B5).

Key to overcoming the barrier of aural communications for DHH students is to provide other complementary or alternative means of communication. Understanding of a communication for a DHH student is often derived from a multitude of factors. In face-to-face situations DHH students will support their hearing with non-visual communications such as body language, facial expression, gestures and by lip reading (A6).   A significant proportion of DHH students lip read, so the use of webcams by tutors (at the very least) during sessions significantly improves communication options. The use of webcams provides the opportunity to replicate online some of the non-verbal communications possible in face-to-face interactions, but this is dependent on having good quality, uninterrupted images. This can be improved further with staff training (C3) on effective use of webcams: speaking directly to the camera with light adjusted to make the lips and facial expressions as clear as possible. Similarly, the use of interpreters (A7) and live captioning (A5) can support and/or replace audio communications.

Other sound related barriers arise from simultaneous speakers or rapid conversations so again pacing (C2) is relevant, and additionally controlling who speaks when (C4). This can be tutor led in a group event such as a tutorial or by agreement within a group as to 'house rules' for participation. BVI students who rely more heavily on aural communications also need these to be clear and for voices to be distinguishable from each other. Ideally screen-reading software needs to be able to identify current speaker indicators. Understanding who is speaking and when is also beneficial to students for whom aural communications present a barrier. The use of icons, speaker identified captions, and webcam spotlighting can help with this to direct the participant to the source of the aural communication. This can assist with lip reading or following a train of thought/conversation between different participants.

With limited access to aural communications, visual communications (A2) take on a greater significance and can provide additional support. The balancing and effectiveness of aural and visual communications is crucial to sensory impaired students.

A2 Visual

Description: Visual communications – images, shared materials, icons, webcams, and whiteboards.

Overview

Visual communications in an online collaborative session can take a number of different forms. This might be shared materials, webcam streams, whiteboards, visual images, icons, popups, slides, and shared screen content.

Restricted access to these visual communication elements as experienced by BVI students present barriers to engagement. Contributing to a brainstorming session on a whiteboard with little or no vision is rarely possible.

Options such as emoticons and icons can be useful and provide an alternative means of non-verbal or written communication (such as slow down, speak up, hands up, or thumbs up) yet the use of these may not be apparent for a BVI student or tutor.

Linked Elements

A4, D1, D2, D3, D4, D5

When participants are unable to see each other a number of possible communication options are removed, as mentioned in A1 - Aural, lip Reading, BSL, gesture, and facial expressions (A6) all contribute to meaning and thereby have potential to enhance engagement. When visual communications are limited during a live session then it is important to make materials and platforms as accessible as possible, so many of the activity and session design (D) elements are impacted. If the materials cannot be read, either visually or with assistive technology, then the student is excluded from the conversation. This again leads to opting out of sessions (B4).

Interventions

A1, C2, C3, C4, D1, D2, D3, D4, D5

Many of the interventions relating to visual barriers come down to activity and session design. Materials used need to be accessible (D3). Activities need to be designed with accessibility in mind too (D4). Utilising accessible materials and designing accessible activities can make a huge difference to a BVI student's ability to participate. This is also extendable to other students for whom following visual materials in a live session is problematic. Providing materials and activity details that are to be used during sessions in advance (D2) enables a BVI student to consume the materials in advance and be prepared to ask questions, discuss, and contribute to a session without the additional load of 'reading' them within a session. Simple adjustments like numbering presentation slides and referring to these numbers allows a BVI student to navigate to and screen read a slide.

Elements included in an online collaborative session have to be readable with screen-reading software (A4). It needs also to be acknowledged that students using screen readers are juggling an additional aural communication channel – the voice of the screen reader – on top of any audio or aural communications taking place. This means pacing (C2) and participation control (C4) are also important. Leaving time for students to read and digest shared materials either visually or via assistive technology is crucial.

Some BVI students use magnification software and are therefore only able to read a section of the screen at a time. In instances like this incorporating screen location into communications can assist a student in finding and focussing on shared content (e.g. "the formula on the top left of the screen…"). Consistency of layout for screen reading (A4) is also crucial. Moving pods or content around the screen during a session can be confusing and disorientating for a student with visual impairment and has also been highlighted as such by students with other disabilities such as dyslexia or mental health difficulties (who may also use screen reading software).   Therefore, layout of screens in a session (D5) is important.

In addition, the complexity, layout, and structure of a learning platform needs to be considered. Screen layouts, colours schemes, contrasts and font size can all help to provide consistency and clarity so as not to overload the senses. Allowing personalised settings of these factors enables a student to optimise settings in line with their preference (A8, D5).

A3 Synchronisation

Description: Synchronisation of sound, visuals, captioning, and interpretation

Overview

Sometimes several communication modes are needed in combination to provide meaning. For example, where hearing is limited then captioning can support this, or communication via a third-party interpreter such as a signer, or non-medical helper. Synchronisation of these communications is important. Aural communications need to be translated to text or interpreted to sign language and vice versa with minimal delays and with as much synchronisation as is possible. In recorded media such as videos, captioning and/or an interpreter can be added subsequently and synchronisation optimised but this is not generally possible in live collaborative sessions when the communication has to be processed before translation.

Linked Elements

A1, A2, A4, A5, A6, A7, C2, C4

When a communication is delayed then it is harder for students that rely on the combinations of modes to engage and make timely contributions. Pacing (C2) and control (C4) of sessions is important here to allow for the additional time required to assess, translate, make meaning, and respond.

If communications are not synchronised this influences the ability to lip-read and make sense of non-verbal communications (A6). The effectiveness of interpretation is dependent on maintaining pace with the conversation so when this is out of sync it is also impacted.   Parallel communications that are not synchronised increases the cognitive load (B5) and therefore in turn increases stress and anxiety (B6). It is nearly impossible to participate in a fast-flowing discussion if communications are delayed for SI participants.

When a screen reader is used then the live aural communications experienced by all (hearing) participants needs to be juggled with the aural communications provided by the screen reader user. This often results in simultaneous overlayed vocal communications.

Interventions

C2, A5

Pacing (C2) is essential here to allow for the time delay created by captioning via stenographer/auto-captioning or for translation via an interpreter. Leaving assimilation and thinking time and allowing for the additional processing is also vital. There is a tendency in online sessions, particularly where visual communications (e.g. use of webcams) between participants is limited, to fill silences with aural communications rather than allow silence to occur, but these silences are essential to allow time for thinking, managing and processing, and for the passing on of information between third-party helpers and SI students.

The closer to real time the communication the better, but in instances like captioning then having the option for a live transcript window (A5) with the history of the conversation can be helpful for re-cap and reflection.

A4 Screen Reading and Navigation

Description: Navigating and consuming online content, visually, through keyboards, and with assistive technologies such as screen readers.

Overview

When working and collaborating within an online environment it is important that students have access to all screen content. Navigating and reading a screen during an online session can be complex for sensory impaired students. The terms 'screen reading' and 'screen navigating' are used to describe ways of moving around a screen and consuming screen content. This might be visually, with different perceptions such as reduced clarity or with a limited field of vision, or through the use of assistive technologies such as screen readers which read aloud content of the screen as a student moves a mouse or keyboard across the screen, or through using a keyboard to tab through screen objects to locate and focus different screen objects.

Screen readers are widely used by BVI students to read text on screen, both standard text, menu items, windows descriptions, and alternative text embedded in images and diagrams. All elements of the screen, including shared documents, have to be clearly readable in a logical, sensible way.

Linked Elements

A1, A5, B5

Using a screen reader means receiving an additional aural communication (A1) which other participants are not going to be hearing and may not be aware of. This has to be managed effectively. It also means an additional cognitive load (B5) as the different aural channels are processed and the content of the screen navigated. When text communications (A5) take place at the same time as aural communications then consuming them with a screen reader becomes problematic: trying to juggle two sound streams simultaneously.

Interventions

A1, C2, C3, C4, D2, D3, D4, D5

A tutor facilitating a group session may not be aware of students using assistive technology, so it is helpful to approach the session on the assumption that they are in use. In fact, many other students in addition to BVI students find screen readers useful.

Screen reading needs to be co-ordinated with aural communications (A1) so that a student is not juggling simultaneous voice and screen reader communications: the participants' voices and the voice of the screen reader, which again comes down to pacing (C2) and participation control (C4). Consistent screen layouts are also helpful: moving windows or pods around a screen and changing the layout during sessions without notification can be extremely difficult for students using screen readers or screen magnification (D5) so keeping layouts consistent and static where possible is useful.

Popups can be confusing and annoying for screen readers, emoticons or fleeting content can be easily missed, and some screen elements simply inaccessible or unreadable so care needs to be taken when using these elements.

It is important to understand which parts or elements of a screen can be accessed and read by assistive technology so staff training in AT and appreciation of its limitations and application to a specific learning platform in use is crucial (C3). If materials are being shared during a session, then providing these as accessible, fully screen-readable materials (D3) in advance (D2) wherever possible, enables students to familiarise themselves with the materials and, if they are unreadable in shared format on the learning platform, have them open in an additional window in order that they may be screen read during the session.

In addition to familiarisation with materials it is useful to be familiar with the environment and context (B1), which increases confidence, and the speed of screen scanning and consumption.

Some students use a keyboard to navigate so screens need a consistent, logical order when navigating. The use of items such as popups, dialog boxes, and notifications can disrupt or cause navigational problems too, so use should be minimised if possible.

Screen magnification is sometimes used by students with limited vision, so activities that jump around the screen or require consumption of several different elements simultaneously are likely to become barriers for these participants. This means activity design needs to consider accessibility (D4).

When using whiteboards then including screen readable commentary or annotation, either within the shared board if it is screen readable, or within an additional text pane, is helpful. Text/chat panes can also be used for BVI student to add their contributions.

A5 Captioning and Text Communications

Description: Live captioning and text communications such as chat panes.

Overview

Text communications such as chat panes can be a useful alternative to voice communications, but this text has to be clear, accessible, and readable by assistive technologies in a practical way. Text communication may be missed by a visually impaired student if they are not aware they are taking place, or if they do not have the assistive technology available to consume them.

If no captioning is available, or it is inaccurate, untimely, or requires continual switching of focus then communications are often impossible for DHH students. This is particularly so if webcams are not used, blocking lip reading and non-verbal communications (A6) which DHH students often use to help make meaning.

Linked Elements

A1, A3, A6

Captioning supports aural communication (A1). It is often the combination of captioning and aural communications (A1) that allows students make meaning. Captioning has to be timely (A3) and reasonably accurate. Captioning can also support lip reading and other non-verbal communications (A6).

Interventions

A1, A4, A6, A8

Captioning is often used in conjunction with aural (A1) and lip reading (A6) in order to make meaning, and it is often the combination of these modes that enables a DHH student to make sense of communications. Balancing these and controlling (A8) which mode or combination of modes is effective in reducing barriers to engagement is often specific to individuals, and the ability to control these factors places the means of access in the hands of the student. Subject specialist terminology can be a captioning issue, but often when options for communicating are combined it is easier to overcome these issues.

Captioning needs to be adjustable (size/contrast) and located within the synchronous environment, placeable, or located close to visual modes such as video/webcam, or the shared content being discussed.

Text communications, such as chat panes, have to be customisable so that a student can adjust the text and background colours to suit their needs. They also need to be able to change the size of the text and identify who said what. Screen readers (A4) need to be able to scan text communications and read individual comments or follow the natural flow of the text conversation identifying the contributors.

A6 Lip Reading and Non-Verbal Communication

Description: Communication through lip reading and non-verbal communications such as gesture, facial expression and body language.

Overview

Deaf or hard of hearing students may rely on lip reading to communicate, or use it to supplement their available hearing. They may also make meaning by picking up on facial expressions or gestures and through body language.

Linked Elements

A2, A8, B5, D5

DHH students rely extensively on lip reading and non-verbal communications (NVC) such as gesture, facial expression and body language to make meaning. For students for whom BSL is their primary language NVC is highly significant in making meaning. BSL is a visual language utilising a combination of gestures and expressions as well as signs, and significantly different from text communications (A5) such as captioning and chat boxes.   So visual communications (A2) such as the use of webcams for speakers takes on a greater significance. Students with hearing loss who do not use BSL may also rely on being able to lip read, so seeing a participant's face to make sense of what is being said helps them to follow and contribute during a session.

Lip reading and making sense of non-verbal communications such as facial expressions and body language can increase the cognitive load (B5).

Interventions

A2, A8, C6, D5

Clear, good quality images of the participants are needed which identifies who is speaking and allow the user to view their face and lips.   Technically (C6) bandwidth has to be sufficient to capture lip and body movements effectively via a webcam, avoiding stilted or unclear images.   Making sure lighting and contrast on the webcam image is also important so that the participants can be seen and read clearly.

In a session, when someone is lip reading the format of the learning environment is important. The current speaker needs to be easily identifiable so that the student knows where to look, and to be able to switch between speakers efficiently and effectively so as not to miss the conversation. The image needs to be clear enough to see the participants' faces. These factors mean the session format (D5) is important, and having mode control so that lip reading potential can be optimised (e.g. zooming in on speakers or spotlighting them).

A7 Interpretation and third-party assistance

Description: The use of interpreters and third-party assistants such as BSL interpreters, captioners, note-takers, and non-medical helpers.

Overview

Interpretation and third-party assistance covers any additional participant in the learning event whose purpose is to transmit communications between other participants and a student/students. This might mean the use of assistants such as BSL interpreters for DHH students, live captioners, note-takers, or the use of non-medical helpers (NMH) to convey communications to students by voice or other means. In each case the interpreter or assistant will follow the session and relay the communications for the student. This requires an understanding from the interpreter/assitant of the context of the discussion, and selection of the appropriate information to pass on. In a learning environment this may also require specialist subject knowledge and understanding of technical or scientific terms.

Linked Elements

A1, A2, A3,

Interpretation may be used in conjunction with other modes of communication such as aural communications (A1), visual communications (A2), captioning (A5), and lip reading and NVC (A6). Synchronisation (A3) of all communications is important so the quicker and more instantaneous the communication the better. This juggling of different modes of communication and switching between interpreter and participants places an additional cognitive load (B5) on the student.

Interventions

B1, B2, C1, C2, C3, D5

When using an interpreter or assistant the information becomes 'second-hand' in that the student is not receiving the original communication but an interpretation of it. There will also be a delay in communications from source to interpreter to student which reduces the chance of being able to communicate with other students in a timely manner. If the interpreter or assistant is at a distance (i.e. not in the room with the student) then they need to be accessible within the collaborative environment and close to any on-screen visual communications that they support to minimise the switching and refocussing required so session format needs to be considered (D5). Allowing the student to have control over the service provided by the interpreter is important so that they can optimise their way of consuming all communications. This may mean being able to show/hide, place and size the interpreter's window, or captioning/notes. Communications between the organiser and/or presenter of the learning event and interpreters/third-party assistants is crucial, so dissemination of information and having appropriate support networks (B2) in place is important. If the tutor/student/interpreter are able to communicate and build up a relationship with each other then this familiarity (B1) should improve the level and quality of communication and engagement. If the material covers specialist academic subjects that may require complex terminology it is helpful if the interpreter or third-party assistant is briefed on this so that they are better able to communication/translate for the student. Communication between all parties is essential throughout the session and pacing (C2) to allow time for the transmitting and processing of information via the third-party. Staff may need experience and training (C3) on working with interpreters or third-party assistants.

A8 Mode Control

Description: Student control over the choice and use of different modes of communication

Overview

There is a need to both consider and implement functionality to determine what control a student has over the ways and means of communication. This might be ways to indicate preferred ways of communication, ways to customise a screen (such as fonts or colours), ways to control and adjust equipment, or ways to customise screen layouts (such as windows or pods). Indicating preference may be controlled by a platform illustrating what modes of communication are active for a participant (e.g. mic or camera).

The ability to have control over their personal settings and screen layouts independent of the default group view can be advantageous. For example, some students (such as those with autism) may find BSL interpreters confusing or distracting and so wish to remove them from their view.

Linked Elements

A1, A2, A5, A6, A7, D5

Having control over the modes of communication lets a student decide how they want to organise and received their aural (A1), visual (A2), and captioning and text (A5) communications, and organise them to best support their own personal needed. This might mean optimising them for screen reading (A5) or pinning an interpreter window. The format of the session (D5) is likely to influence what is possible.

Interventions

A1, A2, A3, A5, A6, A7, D5

Customising and having control over their learning environment can help students to organise their communication channels to suit their own personal needs. This might mean placing captions on the screen in the position and size that suits them, changing chat pane size and position, enlarging or changing the text, altering the text and background colours, pinning, resizing or hiding an interpreter or tutor's window.

In general, the more control a student has over their environment the better, but without placing a burden on the student to customise it every time, or to be bamboozled by technology. Offering simple, standard layouts with the option to customise if needed gives a flexibility to the student to choose how best to engage. Being able to save and apply their own layouts can be beneficial. Having control over the modes of communication can be advantageous for some students, but there is a balance between consistency of layout and personal preferences.

B - Emotional and Social Factors

There are emotional and social factors that present barriers to students engaging in collaborative activities. Lack of familiarity with people, environments, expectations, and activities (B1) can present barriers to engaging. If the appropriate support networks (B2) both social and educational are not in place participation and engagement is much harder.

There is often an obligation to explain needs and requirements (B3), and the potential for misunderstanding if disability is not disclosed or hidden. This leads many disabled students to opt out of collaborative activities (B4).

There is an additional cognitive load (B5) required to engage in online collaborative session with an impaired sense of hearing or sight.

Working with other students can invoke feelings of anxiety, stress, and panic in all students (B6). This is particularly so with students with visual impairment and/or hearing loss. Various elements can contribute to these emotions: fear of the unknown, misunderstanding, spotlighting, or an unfamiliarity with the environment, other participants, or the requirements and nature of a collaborative session.

B1 Familiarisation

Description: Familiarity with the learning environment, people, materials, session format, and what will be expected of them as a participant in the session.

Overview

Familiarisation with all elements of the live activity: people, formats, software, processes, practices, and platforms helps to reduce anxiety, build confidence, and encourage participation. This will need to be built up over time, but the more familiar and confident a student is with their learning environment and its wider context the more likely they are to engage with and contribute to the learning process.

When assistive technologies are provided to students they need time and support to learn how to use these effectively in the HE environment.

Linked Elements

B4, B6

Lack of familiarity with the learning environment, people, materials, session format, and what will be expected of them as a participant in the session can cause stress and anxiety (B6), and cause students to opt out of participation (B4). Anxiety can stem from a fear of the unknown. This is particularly common for synchronous collaborative activities where there may be less time to think and react.

Interventions

A8, B2, C5, D2

Informal sessions with tutors or peers can help break down these fears by building confidence in the environments and with the group. Letting a student control their own engagement in collaborative online activities can build that confidence (A8). They may start as a passive observer, sometimes referred to as 'lurking' so that they can observe what happens, how it happens, and the nature and content of typical online events. Familiarisation with the elements of live collaborative sessions over a number of occasions can help bring a student to a point where they have the confidence to start actively making contributions.

Having informal familiarity sessions with the tutor and tutor group can also be helpful so that the student gets to know other participants and can experiment with customising and exploring the features of the learning environment without having to simultaneously engage with subject materials. Keeping these groups small (C5) enough and consistent so that a student becomes familiar with people enables familiarity with voices and the potential to form social networks which can be supportive (B2). Distributing accessible materials which explain how to do this and allowing access to learning rooms outside of scheduled sessions can also enable the student to explore the environment in their own time. Clear explanations about the nature of group activities such as tutorials, explaining how they will be run, how contributions will be made, what will be required of participants, as well as providing materials in advance (D2) allows the student to prepare both mentally and practically for a session.

Other elements of the model that can help are good support networks (B2), where the use of both peer and tutor mentors can reduce the anxiety created by unfamiliar with environments or group members.

B2 Support Networks

Description: Peer and institutional support networks such as student groups, specialist centres, mentor and personal tutors.

Overview

Support networks both within and external to an educational institution can be important in building confidence, and gaining practical and emotional support throughout the whole of an educational journey is likely to improve both learner experience and outcomes. Learning at distance can be an isolating experience and having support groups can help remove some of these barriers.

Linked Elements

C1, B3

Support networks can provide a structure for dissemination of information and guidance (D1). With appropriate support networks in place the need for self-advocacy (B3) can be reduced. These support networks can also help to provide familiarity with both people and the learning environment.

Interventions

A7, C3

A good support network can dramatically improve student engagement and participation in collaborative activities.

Practical support networks need to be built with assistants such as interpreters, note-takers and captioners (A7), ensuring that all third-party participants have open channels of communication not only to the supported student, but to tutors and other students as well so that the SI student's communications do not become disjointed or distanced from other participants.

Peer mentors can provide mutual support between students. This reduces the feeling of isolation that students can sometimes feel and improve group cohesiveness contributing to the social aspects of education as well as the pedagogical.

Personal tutors, trained in accessibility and catering to the pastoral needs of students, allocated to them throughout the educational journey, can build confidence and performance providing a single point of contact and reducing the need for self-advocacy (B3).

B3 Self-advocacy

Description: The need for self-advocacy and declaration of disability in getting support and access to learning.

Overview

Whilst studying online can allow a level of anonymity this can also cause problems if adjustments are needed to participate and, therefore, disclosure of disability may be required to peers and tutors. When the processes for getting adjustments are complex or repetitive this can place additional pressure on a student and when a component of study is not compulsory this may cause the student to opt out rather than take on the additional burden of self-advocacy.

Linked Elements

B4

Having to declare (or repeatedly declare) disability and required adjustments can be enough to cause students to choose not to participate in collaborative activities (B4).

Interventions

B1, B3, D2, D3, D4

Minimising the need to ask for adjustments or share personal details with peers is crucial. Having support networks (B3) and being familiar (B1) with group members and event participants can reduce the need to repeatedly declare disability and ease anxiety over the need to explain requirements. If the staff supporting the student are able to disseminate those requirements and ensure that activities and tasks are suitably accessible then the need to declare is reduced.

Smoothing the passage to get reasonable adjustments and reducing the need to self-advocate in the first place can be achieved by using accessible materials (D3), designing accessible activities (D4), and by providing materials in advance (D2).

B4 Opting in/out

Description: Encouraging opting in and addressing opting out of online collaborative learning.

Overview

Closely coupled with self-advocacy (B3) is the choice by many students with disabilities to opt out of any activities, or indeed courses, that require engagement and collaboration with their peers and tutors.

Allowing gradual participation can help: allowing students to start as passive observers at sessions, building over time with confidence to full participation. This reduced pressure can encourage students to opt in rather than opt out of these activities.

Students are most likely to opt out of events due to either communication barriers (A) or emotional and engagement factors (B). At the simplest level if a student is unable to communicate, and an activity is optional, then the simplest option available to them is to choose to opt out. Students often choose to 'test the waters' by attending a tutorial (for example) and if they are unable to communicate then they make a conscious decision not to attend any future events.

Linked Elements

B3

Opting out of collaborative activities as a result of the barriers experienced means students lose the opportunity to engage with their peers and create and maintain a social presence as part of the educational experience.

Interventions

B1, B2, C1

Opting out of collaborative events can be for many reasons but it is often related to the learning events being perceived as inaccessible or requiring additional time and effort to enable access. Sometimes a student may not be aware that adjustments or adaptions are actually available as the information is not obviously available to tutors or students.

Some of these can be resolved by ensuring dissemination of information (C1) and making the processes less burdensome or repetitive.

Ensuring all communication channels are supported and available is likely to give the student more confidence in being able to join in. Familiarisation sessions in advance of learning events so that a student can understand the environment and get to know other participants and understand what adjustments they might need and how to get them in place, will make participation easier. Phased engagement can also be implemented so that the student has an option to take a passive role initially but can gradually be encouraged to participate more as their confidence grows. Peer support such as buddy or mentoring systems are also beneficial so that anxieties can be shared and support is available during sessions (B2).

B5 Cognitive Load

Description: the cognitive load required to attend and fully participate in an online learning event.

Overview

The cognitive load placed on SI students in a live synchronous learning environment is high and this needs to be acknowledged and adjusted for. A sensory impaired student may be juggling multiple modes of communication and switching between them. There may be delayed communication due to captioning or interpreting issues. This can be exhausting and place an additional cognitive load on a student in addition to the learning goals.

Linked Elements

A1, A2, A4, A5, A7, A8

Juggling the different modes of communication, aural (A1), visual (A2), screen reading or navigation (A4), captioning/text (A5) or lip reading/NVC (A7) requires more concentration, effort, and cognitive load when one or more of the senses is impaired.

Interventions

C2, D1, D5

To reduce cognitive load you need to control the amount of information that needs to be processed at any one time. Time is needed to assimilate and make meaning, so pacing (C2) is important. There is an increased tendency in online learning environments to ‘fill silence’ as it may not be obvious what participants are doing when they may be working on a problem or thinking through a concept, but thinking and processing time needs to be allocated for these processes.

Consumption of messages from multiple means of communication places additional cognitive loads on students, especially those with sensory impairments or anxiety. It could mean they are straining to see or hear or navigate the screen to find the focus of a discussion. Keeping the volume of materials (D1) and resources being used in a session and keeping the sessions at a manageable length (D5) can significantly help. This might mean running more but shorter sessions or covering less material in a single session allowing time between sessions to assimilate and reflect.

B6 Stress and Anxiety

Description: Dealing with stress and anxiety relating to online learning events.

Overview

One of the most common reasons for students to opt out of collaborative learning is the stress and anxiety that is associated with it.

Linked Elements

Lack of familiarity with the learning environment, people, materials, technology, session format, and what will be expected of them as a participant in the session can cause stress and anxiety. Often this anxiety grows before the collaborative session takes place and this can be caused by a fear of the unknown, so familiarisation (B1) is important to minimise this. When a student understands what the session will involve, who will be involved, what will be required of them, and how the session will be run this can significantly reduce levels of anxiety.

Interventions

B1, B2, C1

During a session anxiety can arise from inability to follow (which can be a result of communication barriers), fear of being 'spotlighted' i.e. asked a direct question by the tutor or one of the other participants, or other reasons such as fear of saying something 'stupid', or misinterpreting the discussion or question. Implementing interventions to increase familiarisation (B1) can significantly help here as can support networks (B2) with peer advocates, mentors, or personal tutors providing points of contact and support both before, during, and after sessions.

If a student knows that their disability has been acknowledged and is confident that the necessary adjustments (if required) will be in place and effective, this is going to reduce stress and anxiety. This means they need to be able to communicate their needs, explain and discuss what might help them attend and engage, and be confident that they have been listened to, acknowledged, and that this information is disseminated (C1) appropriately so that the appropriate adjustments will be in place.

C - Provisioning and Technical Factors

Provisioning and technical factors relate to those factors in the control of the educational institution and the staff within it. This includes making sure that information is effectively disseminated (C1) so that staff are aware of students' needs, that resources and procedures are not only available but are clear, streamlined and understood by all staff. Staff training (C3) is crucial, in all aspects of making collaborative learning online both accessible and inclusive.

In practical delivery and facilitation of collaborative group work pacing (C2), including allowing processing and thinking time is required, as well as controlling participation (C4) so that voices are allowed to be heard. Considering group size and members is important so that students can form social connections as well as academic ones. Where possible technical provisioning needs to be robust so that poor quality audio and visual equipment does not contribute to the barriers. Staff training (C3) in this area and the effective use of technology is also important.

Recordings (C7) of live sessions can be used as additional materials to support students. This can help students reinforce learning or pick up on aspects that they might have missed.

C1 Dissemination

Description: dissemination of information, good practice and open channels of communication between all stakeholders in online learning.

Overview

When information channels are not clear then this places additional burdens on all participants in the learning process. Information needs to be disseminated between all stakeholders in online learning to ensure that communication channels and connections are robust between students, tutors, third-party support personnel and all other participants in the learning process. This includes student information which is held by the institution being effectively disseminated to necessary student support networks including tutors.

Dissemination of information can also cover examples of good practice, effective inclusive activities and material, and the reasoning behind them. This helps build up a library of information and resources which can be utilised by all stakeholders in the collaborative learning process.

Linked Elements

B2, B3, B6

Dissemination of information within an organisation is crucial. If information channels and support networks (B2) are not in place for students, then this places a greater need for self-advocacy (B3) on a student. It can also mean that finding the information they need, the processes to follow, and the adjustments required can be complex, stressful, and frustrating (B6).

Interventions

B2

Students and staff need to know how to get support, what is available, and (in the case of staff) what individual support is needed. This information has to be effectively disseminated so that the processes for ensuring accessibility and inclusion are as smooth as possible and that an unnecessary burden is not placed on student to declare and obtain the support they need. Students also need to understand what is available in terms of support (such as captioners, recording transcripts or printed materials) and how to adjust and adapt the learning environment to their specific needs.

Declaration of needs should not need to be repeated so it is crucial that staff who need to are aware of individual students' needs.

C2 Pacing

Description: the pacing of online live sessions

Overview

Pacing is crucial to online live collaborative sessions such as tutorials and group activities. Online sessions tend to try to cover more information in a shorter time than face-to-face ones.

With activities that require actions from students, sufficient time needs to be given to allow for the use of assistive technology.

Linked Elements

A4, A7, B4, B5

Pacing is needed to ensure there is time for communications to pass through interpreters or third-party assistants or screen readers. When a student is struggling to manage communications then the additional strain of a fast-paced session can mean they feel overloaded (B5) or just opt out (B4).

Interventions

C3, D1

Thinking and assimilation time needs to be given to allow students to process ideas and communications. When reactions cannot be determined by visual clues as in face-to-face sessions there is a tendency to 'fill silences'. With the use of captioning, assistive technologies, interpreters/third-party assistants there is also a delay to some students which may not be perceived by all participants, so it is important that a tutor or facilitator within a session ensures that adequate time is allocated to allow for these delays, allowing participation and contributions by these students.

This requires a balance between keeping the discussions and contributions flowing and ensuring that all participants are able to contribute. This is a skill that can be obtained with experience and staff training (C3) so that facilitators understand how these communications happen and are working in conjunction with third-party assistants. Not overloading the material and work required in a session is also important (D1).

C3 Staff Training

Description: Staff training in inclusion, disability, assistive technologies, creating accessible materials and activities, and delivering accessible tuition.

Overview

Staff need training in inclusion, disability, assistive technologies, creating accessible materials and activities, and delivering accessible tuition in order to be able to provide accessible online collaborative learning and as part of implementing inclusive practice and culture within an organisation.

Linked Elements

C2, C6, D3, D4, D5

Staff need to be aware of how to create accessible materials (D3) and design and implement accessible activities (D4).

Staff need training in the use of technical equipment such as web cameras and microphones (C6) the use of delivery platforms (e.g. Adobe Connect, Teams, Google Classroom or Zoom), and an understanding of assistive technologies.   They also need to understand how to manage sessions in an inclusive and accessible way so understanding the importance of aspects like pace and timing (C2), and session format (D5).

Interventions

A4, B5, D3, D4, D5

Specifically with relation to online synchronous collaborative learning it would be helpful for staff to gain an appreciation of the use of assistive technologies such as, but not limited to, screen readers (A4) so that they can better understand what technologies are being used by students and how they use them.

Assessing materials before use by trialling them with screen readers, and checking the tab order can be very useful as is general accessibility testing of both materials (D3) and activities (D4),

When choosing session formats (D5) keeping duration limited so that the cognitive load (B5) is not too much, keeping layouts consistent and avoiding moving screen components, using inaccessible or distracting/confusing content, and being aware of the use of emojis, popup and polls and their potential impact of screen reading and navigation.

C4 Participation Control

Description: controlling communications and contributions of participants to ensure communication channels are not overloaded.

Overview

Determining who contributes and how is important so that all students should feel they can collaborate, and collaborate in the ways that suit them. This means that some kind of control and management of these communications may be necessary.

Linked Elements

Multiple simultaneous speakers or contributions can be especially confusing for students with sensory impairments, and it is important that all who want should be able to contribute which may require control on the part of a tutor or facilitator or by group consensus. Priority is often given to aural communication online due to the immediacy of their input, but for some students this is not the easiest way to communicate so text and other modes of communication have to be acknowledged and included in the conversational flow.

Interventions

B2, D5

It is helpful to have a provider/facilitator monitoring group participation during, and in advance of sessions. Agreeing modes of communication that allow all members to take part in decision making is crucial.

Participation control can be handled by having protocols, and facilitator intervention. Getting group agreement of ground rules, time scales, objectives, and distribution of workload at the start of a session/project is beneficial. Agreeing on how adjustments to group activity and meetings will be made.

Support networks such as peer advocates and mentors can help by intervening if necessary when participation control become problematic. Again, staff training in managing participatory sessions can be helpful and involving students in determining the ground rules and decision making about protocols makes applying these rules easier.

C5 Group Size

Description: Managing group size to optimise potential for communication.

Overview

When a group is smaller it is easier to establish connections with other group members. Group size needs to be suitable for the activity and workload distribution, with scope for students to participate in ways that are most accessible for them.

Groups that are too large for tutorials and group activities can cause some students to dominate collaborative activities and other to be excluded. Too large groups that are tutor led can end up being lectures rather than tutorials with collaborative activity and student engagement being minimalised.

Linked Elements

D5

Group size can be linked to session format (D5). With a large number of participants in an online event it is often necessary to create smaller sub-groups within the learning environment in order to undertake collaborative tasks. This movement between groups and changing of the learning environment can be difficult for SI students to follow and engage with.

Interventions

B1, D5

For SI students a smaller group size means that it is easier to recognise voices or read body language and facial expressions. As familiarity with a group grows this recognition and therefore interpretation of the communication grows.

Students with hearing loss, but some degree of hearing, are better able to understand and interpret an individual voice when it is more familiar (B1) so maintaining a small group over a number of sessions improves the possibilities for effective and accurate communication and message interpretation.

C6 Technical

Description: technical factors that impact effectiveness of the learning environment such as bandwidth, sound and vision quality, configuration, and personalisation of platform environments.

Overview

Technical problems such as bandwidth, and sound and image quality can impact the effectiveness of communications and SI students' abilities to consume them.

Linked Elements

A1, A2, A3, A4, A5, A6, A7

Technical problems can impact all aspects of communication: aural, visual, synchronicity, captioning, screen reading, and interpretation as quality can be impacted and the timing and fluidity of video fluctuates.

Interventions

A1, A2, C3

Whilst some aspects of the online environment are beyond the control of participants (such as connectivity problems or bandwidth), there are aspects that can be adjusted. Good quality microphones and webcams are needed to minimise sound and image distortion, and staff training (C3) in how to use these effectively. Understanding of requirements of lip readers (face to camera, good lighting, clear image of mouth and normal speech patterns) can be coupled with understanding about use of lighting to allow facial expressions and lips to be read, and staff training in effective presenting on camera, and use of voice and equipment.

Understanding what aspects of the platform can be controlled and how these adjustments impact the participants is also important. If bandwidth is problematic, then controlling aural (A1) and visual (A2) communication by having microphones and webcams in use only when speaking can help. This also helps students identify the speaker faster in order, for example, to lip read.

C7 Recording

Description: The use of recordings to support, document, and reinforce learning within live events.

Overview

Although not strictly synchronous collaborative learning in that they are consumed independently, recordings enable students to revisit and consolidate their understanding of group work, processes and decisions. Recordings allow students to review at their own pace, to pause and reflect, and to familiarise themselves with materials and activities. Although this does not directly support students' engagement during the live sessions it supports their continued engagement and participation as part of a group and as part of their module/course understanding and confidence.

Linked Elements

A5

Recordings need to include captioning and/or transcripts (A5) at the very least.

Interventions

A3, A5, D2

Recording need to include captions and transcripts. Captions need to be synchronised (A3) with the video to get optimum meaning. Any materials and resources used in the context of the recorded session, or resulting from the learning event, need to be made available (in accessible formats) so that they can be consumed in conjunction with the recording if necessary.

D - Activity and Session Design

Design and delivery of materials is crucial to accessibility. Any shared materials (D3) and activities (D4) that will be used in a collaborative online session need to be designed and delivered in line with Universal Design for Learning (UDL) principles[1], and available to students in advance (D2) of the live collaborative sessions so that they have time to digest and familiarise themselves with material and requirements (D4).

Session formats (D5) such as screen layouts, objects used, duration, and volume of content (D1) used in a collaborative session can all contribute to barriers if not considered and implemented effectively.

D1 Volume of Materials

Description: Managing the volume of materials involved in online learning events, either materials shared in advance or those covered during a session.

Overview

The volume of materials used has to be appropriate to the activity and not overwhelming. This might mean breaking materials and activities down into manageable components. Particularly with Deaf students for whom BSL is their first language, managing large amounts of reading can be an additional burden.

Linked Elements

B4, B5, B6

Trying to cover too much in a single synchronised session can cause anxiety (B6) as students struggle to keep up, experience fatigue and mental overload (B5) with the effort of making meanings of communications combined with considering the learning materials. This can mean that students end up disengaging or opting out (B4) if the pressure becomes too much.

Interventions

D5

If a course requires covering a large volume of material, and the collaborative activities include aspects of this material, then it needs to be broken down into more manageable parts. When looking at the volume of material included in a session, such as information on slides or reference and resource documents then these need to be simplified and consumable within the time frame, adjusting for the potentially slower consumption by students with sensory impairments. More frequent, shorter sessions (D5) with smaller volumes of material rather than longer, packed sessions seem to be more effective in encouraging participation.

D2 Advance Materials

Description: advanced provision of materials to be used in online learning events.

Overview

Providing accessible materials in different formats in advance of a session allows students to better prepare. Materials available in advance allow students to prepare for collaborative learning sessions both mentally and practically. Students can familiarise themselves with content for tutorials or group discussion purposes

Linked Elements

D3

Advance materials need to be consistent with those used during a collaborative session and accessible.

Interventions

D3

Materials provided in advance should be offered in a variety of different formats and accessibility tested and evaluated (D3). Making sure these materials can be consumed and referenced during a session is important, so aspects such as page numbering, titles, and consistent formats can help here. Referring aurally to slide numbers or titles helps BVI students identify what is being shared at a particular time.

D3 Accessible Materials

Description: development and use of accessible materials in online learning events.

Overview

This means appropriate use of fonts and colours, alternative text for images and diagrams and staff training (C3) in how to appropriately describe and use visual material.

Linked Elements

A4, D1

Making accessible materials involves making checks and using inclusive design principles when creating them. Materials should be clearly and concisely written. They need to be screen readable, have appropriate font size and colour, and logical and sensible navigation order.

Interventions

C1, C3

Making accessible materials involves appropriate use of fonts and colours, alternative text for images and diagrams and staff training (C3) in how to appropriately describe and use visual material. Basic things to consider include structure, colour and contrast, use of images (including ALT text), descriptive links, clear language and simple tables. There are numerous tools available to check the accessibility of materials, many built into the software used to create them (such as PowerPoint). There are also independent tools available to test colour contrast such as CCA (Colour Contrast Analyser), and colour blindness such as Oracle Color. Web accessibility tools such as Wave let you analyse web content for accessibility. You can also download and use screen readers such as NVDA which is available for free.

Use of accessible templates and accessibility checkers to apply principles can improve the experience of all users when accessing documents. Involving disabled students in the design and development of accessible materials and activities is an effective way to evaluate the accessibility of your materials.

It helps to have an institutional approach and protocols in place for evaluating materials in terms of accessibility and highlighting and correcting materials in use that do not conform.

Well designed and accessible materials can make a world of difference to students with sensory impairments.

D4 Accessible Activities

Description: development and use of accessible activities in online learning events.

Overview

As well as producing accessible materials for learning events it is also important to consider the design and use of activities constructed for live events. Developing accessible activities is about ensuring all students can participate, join in, and contribute.

Linked Elements

When activities are assessed the learning outcomes need to be genuine measures of competence relevant to the program and non-discriminatory by design. If an activity designed for collaborative working is not accessible it puts SI students at an immediate disadvantage and often requires declaration of their disability in order to be able to participate. A well-designed, accessible activity is one that all are able to contribute to.

Interventions

D2, D3

Trialling activities with disabled student groups prior to release can help identify and resolve potential problems. When starting a collaborative activity building in and embedded scaffolding of support for students, so that they can then move forward with it as a group, improves the chance of success.

Clear guides should be provided in advance on the nature and assessment of collaborative activities to allow for preparation and adjustments if required.

These activities should be designed with an understanding of the use of assistive technologies and alternative methods of interaction, allowing sufficient time to complete in whatever way the activity is accessed and implemented.

Any materials associated with the activity also need to be accessible and provided in advance.

D5 Session Format

Description: format of sessions including duration, organisation and planning of program of activities and session plans.

Overview

In order for collaboration to take place in an online tutorial there needs to be participation and engagement from both tutors and students, and the student needs to be encouraged (but not forced) to take an active role. The format of the session can influence how effective this is. This can include the duration and frequency of the session, how a program of activities and sessions are planned, and how a learning environment is set up, formatted and controlled.

Linked Elements

C2, B1, B2

Aspects such as duration and frequency of a collaborative event can be closely linked with pace (C2). Well-paced sessions with a reasonably short duration that allows enough time to learn but at a workable pace that does not create excessive cognitive load are the basis for a good format. Planning these sessions so that a group can build cohesiveness, mutual trust, and familiarity is also crucial to the effectiveness of the learning.

The format, set up, design and control of the learning environment is also a crucial part of the session format.

Interventions

A8, C2, C4, C5

The nature and size (both in material covered and participants involved) of the collaborative learning component of a course will determine some aspects of a session format but controlling group size, either by breaking a group down into smaller sub-groups or by keeping the group size small in the first place, can offer more chances for engagement and active participation by the students. Giving control to the students over some aspects of their learning environment (A8) is important so that their preferred means and modes of communication can be implemented. Shorter, more frequent sessions often allow for greater group cohesion and less strain on participants in terms of cognitive load. Allowing groups to determine their own ways of working and negotiating group rules and protocols also allows students to make sure they can work in the ways that they are best able.

7 Discussion

This chapter summarises the research outcomes of the series of studies and looks at both contrasting and complementary perspectives provided by the different user groups. It discusses the findings in relation to each of the research questions by looking at how the barriers were identified, how interventions were developed, and what has been learned from the studies. The first three sections reflect on the research questions. The final section reflects on the use of DBR and the product (MACE).

7.1 RQ1 - How can we improve inclusivity in online collaborative learning for students with sensory impairments?

We can improve inclusivity in online collaborative learning for students with sensory impairments by learning from the students and staff where the problems are and determining *with* them what we need to do to address them. The framework evolving from the research is visualised in a model (MACE) and brings together the findings to create a picture of what needs to be in place in order to optimise accessibility for SI students and allow them to actively engage and participate in online synchronous collaborative learning. By considering each aspect of the model when designing and implementing collaborative learning events online we can improve inclusivity for SI students so it provides practical advice.

The framework and model are built on the barriers and interventions identified. The relationship between the factors and the barriers requires some clarification: the factors are elements of the model that make up each of the core pieces (Communications, Emotional and Social Factors, Provisioning and Technical Factors, and Activity and Session Design). What emerges from this research is that all of these factors need to be addressed and considered in order to provide an improved online learning environment for SI students. In some instances, such as (B2) Support Networks, it is the absence of the factor that presents the barrier. In others, such as (C2) Pacing, it is the controlling of the factor that needs consideration. Other factors, such as (B4) Opting Out, are factors that need addressing to ensure they are minimised. The key to all of the factors is that they are elements that need to be considered and addressed in order to optimise engagement for SI students, and that by doing so for this group of students it is likely that engagement can be improved for all students.

There is naturally much interdependency and overlap between some of these factors as they are all part of the holistic approach and hence the jigsaw analogy. Only when you see the pieces all joined together do you get a clear, complete picture. By doing this, and by use of the associated framework and model, I believe we can answer RQ1 by saying yes, we can improve inclusivity for SI students in online collaborative learning, and especially the most complex synchronous environments.

This research recognises the complexity of the issues and the diversity of this population and uses and builds on prior research bringing it together into a framework that embodies all aspects. This holistic approach, spanning all levels of hearing and sigh impairment and providing practical solutions developed with the active participation of SI students is what makes MACE effective as an inclusion tool.

7.2 RQ2 What are the barriers to engagement for students with sensory impairments?

In answer to RQ2 the research identified barriers and established that these barriers could be related to the factors making up the core categories of the MACE framework.

The key purpose of studies P1S1 and P1S2 (survey and student interviews) was to identify the barriers to engagement for sensory impaired (BVI/DHH) students in online collaborative learning in response to RQ2. This initially required testing two fundamental hypotheses, the first being that online synchronous events presented specific barriers that might not be present in asynchronous and/or face-to-face event, the second being that student with sensory impairment (BVI and/or DHH) experience more significant barriers than their peers.

Targeting BVI and DHH students in the survey for P1S1 gave a voice to this sector of the student body and by including a sample of sighted and hearing students within the respondent group it was possible to have a group with which to make comparisons. Crucially, this research was not restricted to blind and D/deaf students as is the case with much of the existing literature (Doherty, 2012; Betts *et al.*, 2013; Kohlmann and Lucke, 2014; Baldwin *et al.*, 2017), but inclusive of impairment at a level which impacted engagement, reflecting the diversity and individual needs of students with SI. Defining these groups was achieved through categorising the students based on several criteria, and as such did involve some discretion and interpretation by the researcher. It was important to get this classification as accurate as possible and by using multiple factors to classify students, including their own definitions and descriptions of their impairments, many of the students classified as BVI or DHH had more than one factor supporting this classification which added a level of robustness to the grouping.

To test the hypothesis that online synchronous events were more problematic than other learning environments (online asynchronous, synchronous face-to-face), sections of the survey addressed each of these options to allow comparisons to be made. The content analysis revealed that online tutorials received the most coded responses, and the highest proportion of negative responses emerging from a spread of participants. There is bias in the selection of the coded responses in that the researcher was actively looking to identify barriers, and this goal influenced what was and was not coded, but with the same intention applied through all sections this still seems to indicate that the richest data in terms of both the thematic and content analysis came from the online tutorial section of the survey supporting the supposition that this is the area where engagement with collaborative learning is most problematic. The wider dataset, through both quantitative and qualitative analysis, also supported this supposition that online synchronous collaborative learning events present the most barriers. Studies such as Kang and Shin (2015) suggested the advantage of synchronous e-learning and this research produced evidence that these events were more problematic for SI students.

Identifying the four coding categories for barriers was achieved through a reflective thematic and content analysis process. Again, there is potential for researcher bias here, but the iterative nature of the studies, reflection on existing research such as Alshawabhek et al. (2021), Almeida et al. (2020), and the re-presentation of the data to different participants in subsequent studies allowed the coded elements in each category to be re-evaluated with new insights, and new perspectives, from each stage. The re-coding and recategorising also had the effect of clarifying some areas and grouping others.

Whilst the four coding categories remained reasonably constant throughout all five studies the definitions and nuances of the codes were changed as the bodies of evidence increased.

The first category to emerge was the communications category. The letters/numbers here indicate the model elements as described in Chapter 6.

7.2.1 Communications

Unsurprisingly the main barriers to engagement experienced by SI students were related to the inability to effectively communicate with their peers, tutors, or facilitators as has been recognised previously (e.g. Kawas et al., (2016), Rubegni et al., (2008)). Similarly, and equally unsurprisingly for the target student groups, aural (A1) and visual (A2) communications provided the most significant barriers. But, most importantly, these constituted only part of the picture, and the nature and construct of communications barriers became more complex and nuanced as the research progressed. From the initial survey results it was obvious that being unable to hear voices restricted DHH students' ability to follow discussion and conversations and, similarly, being unable to see or consume shared resources and written communications had an impact for BVI students. The nature of the communication challenges became more intricate when the variety of different ways and means in which the students chose and preferred to communicate came to light. Extending beyond D/deaf and Blind students, the multitudinous nature of SI students' communications became apparent. Both groups of students indicated that owing to the nature of their impairments they communicated in different ways, and it was often combinations of these modes of communication (A8) that enabled them to make meaning. These combinations varied from student to student and, particularly in the group of both BVI and DHH participants, generating the 'perfect' balance of these communications modes was key to enabling communications. Considering this with respect to the UDL approach it suggests that not only does their need to be multiple means of engagement, representation, action, and expression but also that some individual students may need to implement multiple means personally in order to engage. The voice of the student in determining accessibility is an integral part of this (Coughlan et al., 2017; Hewett *et al.*, 2020) and is missing from a purely UDL approach. Accessibility for DHH students might be being able to lip read, or to see faces, to recognise gestures and body language, to read captions, to follow a BSL interpreter or a third-party assistant, or to focus on text communications. A contribution of this research is an understanding that all of these different modes might be used in different combinations, and with different weightings of importance by different students.

One of the significant findings for DHH students was the extensive use of lip reading (A6) as an alternative to hearing or as a means to supplement residual hearing which was much wider spread than anticipated. The proportion of respondents who lip read (42.7% of DHH) was surprising and the default online presence without webcams provided one of the most significant barriers to these students. This needs consideration and could represent a bias in the study as utilisation of webcams may be more prevalent in other institutions so is perhaps an area to be explored in future studies. Having a visual presence was important not just for lip reading purposes but in order that other non-verbal communications (A6) could be exchanged and interpreted: gestures, facial expressions, and body language. Lip reading as a tool for communication is very much dependent on context and non-verbal communications can provide this context and therefore enable more accurate lip reading.

Similarly, with BVI students, the nature of the visual impairments determined how, and in what ways they communicated. Screen reading was a significant mode of communication for many BVI students and the unreadability of some learning platform elements and shared resources was a major factor in limiting their ability to engage. Whilst initially screen reading was considered just in the context of utilising screen reading assistive technologies to consume screen content, it became obvious that there was a more general problem with consuming visual communications by interpreting screen content. This related to the way screen content was 'seen' visually as well as how it was navigated. Problems were broadly related to using the keyboard to navigate or utilising limited vision to focus on parts of the screen and the navigational issues this brought about. The decision was made, therefore, to consider screen navigation (A4) in the broader context of navigation and consumption of content through software, vision, or via a keyboard. Whilst different ATs were utilised by students, the majority of coded references which could be linked to barriers to engagement related to screen reading software, so this indicated a natural grouping of screen reading and navigation. Aspects of screen reading not related to navigation were covered by other elements such as the synchronisation (A3) problem of text to voice communications with aural communications (A1), the use of screen-readable accessible materials (D3), the learning curve required to familiarise a student with the software (B1), and staff training (C3) and understanding of ATs.

Students were used to stop/starting screen reading, slowing, and speeding it up in a session, and juggling the AT responses with aural communications, but indicated the increased cognitive load this necessitated. Similarly, they were used to working with materials designed without accessibility considerations, and having to navigate untagged images and diagrams, non-sequential object order, and general poor design. One of the focus group members talked about the elation of getting really well-designed, screen-readable materials and how it highlighted for them how poor the general quality was and how much extra work they were needing to put in just to consume the shared materials. This one aspect of staff training (C3) – making accessible materials (D3) – could have a huge impact on BVI students and other users of screen readers.

Reflecting on the need to juggle different modes of communication it then became apparent that these needed to be co-ordinated and synchronised (A3). When communications become asynchronous in a synchronous learning environment, as can happen with the inclusion of third-party assistants such as interpreters, live captioners, or non-medical helpers, the student is denied the opportunity to engage in the conversation.

For effective communications between participants in online synchronous collaborative learning sessions involving sensory impaired students all eight of these potential communication barriers need to be considered. It is only by considering all of these identified factors and their potential impact on a student's ability to communicate that we can create an environment in which they can collaborate.

When reflecting on these findings in the context of the literature review it was possible to see that the research supported some of the existing research related to barriers, but also managed to identify some of the connections between the studies, identify new barriers, and provide some possible solutions. There was a significant emphasis on the discrepancies between written/oral and sign languages in the literature research (Bottoni *et al.*, 2013; Skedsmo, 2016; Ulisses *et al.*, 2018), with an emphasis on Deaf as apposed to DHH students and, whilst this is obviously still a factor and a significant issue, it fails to acknowledge the complexities of communication for students with some hearing, and for those who do not use BSL or use it as a secondary language. Whilst the findings reflected the conclusions of Alshawabkeh, Woolsey and Kharbat, (2021), that use of an interpreter broke the student-tutor or student-student relationship impacting both the effectiveness of communication and the social aspects of collaborative learning, this research indicates that this distancing also occurs with other third-party facilitators such as captioners, note-takers, and assistants breakdown this connection.

The findings also support those studies around consuming content such as whiteboard via screen readers (Freire *et al.*, 2010), but the broadness of approaches BVI students had for attempting to read these was more varied than might have been assumed. This is something emerging from this research. Realising the impact that a lack of an 'overview' has on students seems to be a significant feature here. Whilst sighted students are able to scan a screen for an overview and then focus on a specific item or area under discussion, a BVI student will often get this overview only by piecing together the different items or areas. They might do this by utilising different tools or approaches, so this might be using restricted vision to zoom in on an area and moving the screen around incrementally into their field of vision, or by passing a screen reader over the screen to find objects in order to interpret the content.

7.2.2 Emotional and Social Factors

Whilst communication was crucial to engaging in collaborative learning, a more surprising category of barriers that were identified related to emotional and social factors. This category emerged more slowly in the research, but it became apparent that non-academic or pedagogical factors relating to collaborative learning were also presenting barriers to students. Social presence and social interactions have been seen to be an integral part of collaborative learning but social interactions can be much more complex for SI students. Collaborative learning has been seen to have generally negative perceptions from students (McGarrigle, 2013; Campbell *et al.*, 2019; Hilliard *et al.*, 2019), but there have also been positives associated with collaborative learning relating to social presence and personal growth (Oliveira, Tinoca and Pereira, 2011; Barkley, Major and Cross, 2014; Garrison, 2016). Whilst these studies looked at the wider student population's perspectives, what emerged from this research was that whilst some of the barriers that were experienced by SI students were the same as those identified for the general student population, these were often exacerbated by sensory impairment and there were additional barriers directly attributable to their disability.

Students often had not experienced collaborative learning or group tutorials or activities before joining the Open University, so stress and anxiety (B6) were often linked by students to the idea of working in this way. Whilst these feelings were experienced across the student population the fear experienced by SI students was increased by their worries in relation to not being able to understand, follow, or contribute effectively as a result of their hearing/sight. There was a fear of misconstrued communications making their contributions inappropriate or repetitious, so rather than make a 'mistaken' contribution, students often chose to take a passive role in collaborative activities. This opting out (B4) of collaborative work also extended much further than had been anticipated. SI students, particularly DHH ones, were less likely to attend online tutorials, often choosing to listen to recordings rather than follow a synchronous event. This again led to a passive role as questions could not be asked, activities could not be undertaken, and interactions were not possible. At the extreme, this opting out resulted in students withdrawing from modules where collaborative learning was a requirement or assessed component. This was particularly applicable to STEM modules where scientific experiments and laboratory partnerships were a common approach. The concern here was that much of this opting out activity was going under the radar of the University. When analysing the sample student data provided by the University it became apparent that a disproportionate number of DHH and/or BVI students had withdrawn from modules (see Statistical Analysis #2). Whilst this cannot necessarily be attributed to the presence of collaborative activities in these modules it may be a factor and does provide potential for further studies into the reasons behind this disparity. Opting out in the context of the model was interpreted as either taking a passive role in a synchronous online event, electing not to participate at all, or actively avoiding module where synchronous collaborative participation was a required element.

The additional cognitive load (B5) that is experienced by SI students was also something that emerged from the research. The intense concentration required to follow conversations, participate in activities, and read materials led to students talking about the exhaustion they felt after a tutorial or group activity. This often led to a 'zoning out' when the cognitive load became too much. This was an area discussed in great detail in the focus groups, where opinions suggested that hearing/sighted students and tutors would have difficulty understanding how much harder it is for SI students to follow, and just how much effort this takes. This was particularly true when pacing (C2) was fast, and time was not allocated for processing or thinking. When all senses are fully functional the ease of multi-tasking, such as scanning a screen whilst listening to someone talking, is often taken for granted and meaning is easier to construe.

Other emotional and social factors that emerged related to familiarisation (B1) and support networks (B2). These codes emerged later in the studies and had not been identified as such in the survey. It became apparent when coding that familiarisation was important in both building confidence and in reducing the cognitive load (B5). Familiarisation with all factors of the learning experience made it much more accessible: the software, the people, the materials, the session formats, generally all aspects of the collaborative learning experience. Having support networks in place can be closely linked to this. Peer mentors, a constant personal tutor throughout the student journey, and a social network with which to share both academic and personal struggles and discussions all helps to build confidence and increase familiarity.

The final component identified in this category was labelled self-advocacy (B3) and this really related to the additional time, effort, and emotional barriers presented to SI students in getting the adjustments and materials they needed in order to participate and how this often delayed their progress. The need to repeat requirements necessitated a great deal of self-advocacy on a continual, module by module basis, and this again links with the concept of both dissemination (C1) and support networks (B2) and how not passing on student information and having multiple points of contact make this self-advocacy necessary. Again, when the effort required to get adjustments became too much, students were choosing to opt out.

Existing literature on the emotional and social factors causing barriers for SI students was less apparent than that relating to communication barriers. Whilst the importance of social interactions was identified as crucial to collaborative learning (Oliveira, Tinoca and Pereira, 2011; Garrison, 2016; Stahl, 2018), the research identified a much wider selection of emotional and social factors contributing to disengagement and inability to engage. There is a body of research identifying the importance of change required within institutions (Fichten *et al.*, 2009; Bualar, 2018), and the need to embed accessibility but this mainly tends to come from a UDL or reasonable adjustments approach and is not taking a holistic view of both the organisation and the individual student.

The key lesson that emerged from the identification of these barriers was that the learning environment had to address these emotional and social factors first in order to be able to take on some of the other factors. If a student is opting out because of emotional or social factors, then these need to be addressed before any learning event can take place. These aspects are often under the radar of an organisation.

7.2.3 Provisioning and Technical Factors

It was clear that some significant barriers experienced by students related to provision and technical factors. There were significant problems with the robustness and clarity of the provisioning platform relating to connections dropping, quality of sound and vision and other related technical issues. Some of these potentially arose from the students' own internet connections and therefore outside of the control of the University, but it also became apparent on researching the provisioning platform that some of these problems arose from the poor level of quality that was technically possible on the platform. Every factor that puts an obstacle in the path of access to the learning environment for students in online collaborative learning places an additional load on those with sensory impairments particularly for BVI students who may experience problems navigating to or back to the rooms the sessions are being held in. Connection error messages were identified as not screen readable and lost links often required back-tracking through the module site to re-establish a connection. This process is exacerbated for SI students when the screens and steps have unnecessary complexity. DHH students were not always aware if the sound issues related to their hearing, their equipment, the tutor or facilitator's equipment, or the learning platform itself. Barriers relating to participation control were not limited to access to the platform, but also to how users within the environment were able to participate, and control over who contributed when. This was important in terms of the barriers presented to DHH students relating to multiple speakers.

On the provisioning side one of the most significant barriers, and something that had an impact on many other factors, was the speed and pacing of sessions. Interpretation and captioning make communication time longer, as do screen-reading and navigation issues. This is in addition to the potential delay time relating to the processing and making meaning of communications for SI students.

7.2.4 Activity and Session Design

Materials and activities used in online synchronous sessions provided significant barriers for students. This could be related to the sheer volume of materials (D1), the lack of consideration for accessibility in designing these materials (D3), not having access to the materials in advance (D2), and the design and implementation of collaborative activities (D4) not incorporating accessibility as a core design component. What was very clear from the research was that accessibility and the principles of Universal Design were not being applied in the design and implementation of tutorial materials and activities. This appeared to be fundamentally down to lack of training or understanding of staff in how to produce accessible materials.

A surprising finding of the research in respect to the use of screen readers was the low expectations students had in terms of the quality of shared materials and general delivery of the sessions.

The strength and uniqueness of this research is its wide-ranging approach. These barriers provide a much more comprehensive view of the problems encountered in online learning for DHH and BVI students. Whereas previous studies focussed on primarily blind or D/deaf students, by including the fuller range of sensory impairments a much more complex picture emerged. This revealed a multitude of ways and individual differences in which SI students experience barriers to engagement in collaborative learning. By exploring and contrasting asynchronous and synchronous, face-to-face and online learning the specific barriers relating to online synchronous collaborative learning were revealed.

So the simple answer to the research question is that there are barriers to engagement for SI students and these have been identified and categorised in order to understand them.

7.3 RQ3 - What interventions can we design that might improve inclusivity for sensory impaired students in online synchronous collaborative learning events?

Involving staff in studies P2P3 and P2S4 (interviews and workshops) and addressing the barriers identified by the students in P1S1 and P1S2 (survey and interviews), enabled interventions to be explored and discussed. Each of the workshops was able to review and add to the findings of the previous workshops so that the body of potential interventions grew. The focus group were able to take an overarching view of these interventions to determine what the ideal picture would be for optimising inclusion and accessibility.

The key to reducing barriers for access to online collaborative learning is to take a holistic view of the barriers and consider all four categories of identified barriers when implementing an institution-wide approach to embed a culture committed to inclusion. Addressing communication barriers, and accessibility of materials and content is not sufficient to make a truly inclusive, accessible learning environment. To do so you also need to acknowledge and address emotions, social, design, technical, and provisioning factors too.

Before a student even attempts to participate in an online synchronous collaborative learning event a number of factors need to be addressed. The student has to be able to attend that event with confidence that their needs will be met, with the minimum amount of stress, and with the knowledge that there is a support network there for them. Having support networks (B2) in place prior to attendance is a good way to achieve this. These can consist of personal tutors, peer mentors, and third-party assistance as well as their peers and subject tutors. Keeping the communication channels open and ensuring dissemination (C1) of information between all participants in these support networks allows students to feel less isolated and better able to address their worries and concerns. This communication needs to extend to involvement of third-party participants in a learning event such as interpreters, captioners, note-takers and non-medical assistants. If communication is open before, during, and after an event and relationships are formed between all stakeholders then it is far easier to address and acknowledge problems when they occur and to assimilate and disseminate the lessons learned so that they can be put into practice. When a student is familiar (B1) with people, the environment, and the expectations that will be placed upon them then the stress levels can be reduced and the chances of students opting out of the event are reduced. Having a single point of contact on staff, a personal tutor in a pastoral role with a responsibility for supporting the whole of their journey allows a student to disclose and explain their needs once to this contact who can then disseminate that information (with the students' consent) to other tutors. This also allows them to develop a relationship with the tutor, who can guide them, advise them, explain how tutorials or group work, and direct them to existing support networks of both student and staff. Student mentors can also help fulfil aspects of this role, sharing experiences and advice. Similarly, when third-party support (such as captioners, interpreters, and assistants) is needed to attend these events, meeting and discussing needs with them and the tutors prior to a tutorial will build confidence.

One of the most significant barriers on the provisioning side of learning in an online synchronous event is lack of understanding and training of University staff in implementing inclusion and accessibility in practice. Staff need to be trained in order to be able to design and deliver online tuition effectively, inclusively, and accessibly. Training in effective use of the learning environment and the technology has to extend beyond a simple understanding of the features of a learning platform to how to use them effectively and inclusively. This might be understanding how to use a microphone to optimise clarity, or how to use a camera and adjust the lighting to optimise visual clarity so that a student can clearly see lips, facial expressions, and body language. They need to not only understand how to design and produce accessible materials, but also to have an appreciation of how they are consumed which might involve gaining practical experience of using assistive technologies such as screen readers. If they are able to test their resources using a screen reader it will develop a better understanding of how the students will consume that resource. Making accessibility and inclusion training part of the induction process for new tutors and providing additional training for existing tutors is a way to implement this. Involving disabled students in the design, production, and delivery of this training gives an active voice to the disabled student community.

Having considered student and staff needs and training, interventions relating to the provisioning aspects of delivering online tuition were evaluated. Emerging from this was the need to facilitate aspects of sessions in order to optimise inclusion. This included participation control, group size, session formats, and the pacing of tutorials. The key here seemed to be that the technical provisioning (C6) has to be robust, controlling access and participation (C4) has to be streamlined, and that the tutor or facilitator has to take a lead role in this process. This required staff training (C3) covering technical and pedagogical aspects, and in terms of accessibility. The learning platform needs to be robust and accessible. Whilst the choice of platform and the specific problems relating to the usage of Adobe Connect are outside of the scope of the research, handling the way the learning environment is managed in general is possible in relation to aspects such as consistency of volume and clarity of sound and vision through the use of good quality equipment, and lighting and contrast considerations in the use of webcams.

In terms of speed and pacing the difficulty of gauging the correct speed in an online synchronous environment provides a significant problem. In a face-to-face environment it was acknowledged to be easier to judge pace by scanning the room and observing reactions and focus of the students. One of the key lessons here seems to be to control pace, allow thinking and reaction time, and to understand and acknowledge that this will often be longer for BVI and DHH students.

The overwhelming feeling from staff involved in the research was one of a desire to improve accessibility, but the lack of training or understanding of how to do this was presenting significant barriers to both staff and students. As an institution reliant on associate lecturers based remotely, mostly part time, and at the time of the research on module-by-module contracts, this core training was difficult to implement and financially demanding. Whilst some of these matters are beyond the scope of this research, it does suggest that a cultural shift in attitude to accessibility and the embedding of accessibility training and implementation is required by the institution in order to redress these barriers.

7.4 Reflections, Contributions, DBR, and Context

This research required the active participation of the target student populations (BVI and DHH students), but also the contributions and perspectives of other stakeholders in the collaborative learning process. In considering methodological approaches to ‘liberate’ disabled student voices, Seale (Seale, 2014, p. 191) talks about the need for methods that offer opportunities for critical self-reflection but also enable a dialogical relationship to be established with disabled students in which they are genuinely heard. Utilising a DBR approach enabled this to take place.

The studies succeeded in involving a diverse selection of both students and staff, including representatives of all significant stakeholders in the collaborative online learning process. The respondents to the survey were, aside from sensory impairment, broadly representative of the student population demography as illustrated in the descriptive statistics section (5.2.4). A significant number of students from the targeted student populations (DHH and BVI) were actively involved in the research as survey respondents, interviewees and focus group members. These students provided a wide spectrum in terms of both level of impairment and the nature of their sight/hearing capabilities. There were also representatives of students at different levels of study and from different faculties, following different study patterns and paths. This was important as approaches to collaborative learning and the nature of activities, tutorials, and group work varied significantly between faculties. Students without SI were included for comparison. This allowed contrast between sighted/BVI and hearing/DHH.

In order to determine what we could do to address these barriers it was necessary to hear the voices of all staff involved in collaborative learning events. Included in the studies were tutors with and without experience of tutoring DHH and BVI students, tutors who are DHH and/or BVI, Staff tutors, Learning Design specialists, Student Support officers, Post-Graduate Research students, Module team members and Module team authors/designers.

The iterative and cumulative nature of the research allowed all of these voices to be heard, and their inputs to be recorded and passed back through the design process. The framework/model design evolved primarily from these voices. However, whilst this enabled an iterative, collaborative, inclusive approach to the research it did have the consequence of making the data analysis multifaceted. Refining and reviewing the data and the codes after and during each study was an extremely complex process and clear cut off points and stages had to be created at the end of each study to maintain perspective on the growth and development of the model. It was important to maintain the model at each phase in order to understand how, why, and where the changes had taken place. Mapping the data between each phase and to the final model helped elucidate some of these changes and allow for reflection on the changes and their significance. The coded data was maintained in repositories representing each stage so that it could be revisited and reflected upon.

Although the data analysis was implemented independently by the researcher in studies 1 to 4, the final study (study 5) involved the active participation of the focus group in the analysis and evaluation of the framework and model, with the researcher summarising the findings and changes at the beginning of each meeting where they were discussed and mutually agreed upon, modelling good DBR practice.

In order to understand the barriers and to determine and evaluate the potential interventions to collaborative learning in an online synchronous environment I felt it was crucial to undertake the research by implementing a collaborative learning approach and utilising this precise context. This meant running the focus group online in a synchronous environment for the key sessions.

As the focus group stage also involved practical evaluations of the framework interventions for assessment purposes, there was a balancing process required to ensure that this was implemented in ways that did not impact the outcomes of the evaluation, i.e. the consciousness of what was being required of the participants did not influence their outcomes. Whilst it was possible to discuss all aspects of the framework within the focus group, it was not possible to implement practical evaluations of every aspect. The aspects for practical evaluation that were chosen were both practically possible and least susceptible to influence by consciousness of the process. These included evaluations of aspects such as familiarisation processes (which were implemented before the first meeting of the focus group), accessible materials and activities, and support networks.

Supporting the synchronous online sessions with asynchronous collaborative activities and one-to-one familiarisation sessions enabled the lessons learned from the first two phases of the research to be actively trialled and developed in an iterative demonstrative way in parallel with, and as part of, the research studies themselves. On the whole I found this approached worked effectively, although it presented its own challenges. The original proposal had been to initiate the focus group with a face-to-face meeting so that group members could get to know each other, so that we could collectively decide and agree on group rules, and so that we could implement the familiarisation processes that had been identified as an intervention to removing barriers for the student group. The pandemic made this untenable, so the first group meeting had to take place online, and participants were asked to introduce themselves online in an asynchronous closed forum. While this did help with the familiarisation process, and the group did gel and communicate very well by the final session, it meant that more of the first session was taken up with introductory activities and practicalities than had originally been planned, leaving less time for discussion. Limiting the cognitive load by managing the timing, pace, and duration of the sessions restrained and informed the model design process. To mitigate as many technical and platform familiarisation issues as possible prior to the first meeting of the focus group one-to-one familiarisation sessions were held with each participant. This allowed the participants to meet myself as the researcher and discuss and assess how to utilise the facilities within Microsoft Teams to support their communication needs.

It was interesting that by the third session one of the DHH participants talked about how he was finding it much easier to 'hear' what the other students were saying now that he had gained a familiarity with their voices and was having to concentrate less on understanding what they were saying. Familiarisation was obviously important in terms of tackling emotional and social barriers as well as communication ones. Other participants echoed this response.

Reflecting on the use of DBR as a methodology, this was an appropriate, suitable, and relevant approach, but highlighted the complexity and difficulty of managing a design project within a major institution such as the OU. Whilst initially Action Research was considered this approach is normally carried out independently and the researcher remains detached from the design process. In design-based research, both researchers and participants are engaged in all stages of the research from conception to reflection. Critiques of DBR have argued that "if a researcher is intimately involved in the conceptualization, design, development, implementation, and researching of a pedagogical approach, then ensuring that researchers can make credible and trustworthy assertions is a challenge" (Barab and Squire, 2004, p. 10). Yet others suggest that "Some qualitative proponents argue that the researchers themselves (with their biases, insights, and deep understanding of the context) are the best research tool" (Anderson and Shattuck, 2012, p. 18). The choice of DBR made the research process much more complex, because of the need for iteration and active involvement of the participants in this design process, however it is this active input of participants – particularly the SI students - and the iterative nature of the studies that ultimately gives validity to the findings to defend Barab and Squire's challenge. As someone with hearing loss, who had been a former student, active tutor, and a researcher at the OU my understanding of the context was something I felt was contributed to the research. Making sure this understanding did not unduly influence the direction of the research was something I was constantly aware of. Sharing my assumptions and analysis as part of the iterative process in order for it to be evaluated by others was a way of mitigating bias. It is believed that this research also contributes to an understanding of the effectiveness of a DBR approach in this context. It is hoped therefore that the lessons learned from this research also contribute to DBR as a methodological approach too.

The choice of a mixed methods approach and the range of different methods for both data collection and analysis I feel ultimately provided a more comprehensive picture. The separation of studies for students and staff had benefits in terms of gaining different perspectives but it was bringing these two groups together in the focus group to develop the framework that highlighted the differences and commonalities between the different perspectives. Introducing a staff/student workshop into study 4 might, in retrospect, have brought together each of the groups at an earlier stage and therefore better informed the focus group.

The combination of thematic and content analysis was effective in producing the categories and themes. Validating these themes by showing both the quantity and distribution of coded references, the number of different respondents and their sensor impairment category contributed to determining the importance and relevance of each theme.

Whilst the research did actively involve a large number of DHH and BVI students with a diverse range of impairments in the research, there are a number of factors than need to be considered when evaluating the strength of the findings. Whilst SI students were categorised as BVI, DHH, or BVI and DHH, there were a number of other disabilities declared by students. It is also sensible to assume that they may have other undeclared disabilities too. Sensory impairment does not exist in a vacuum and each participant is an individual with different physical and cognitive capabilities as well as sensory ones.

The mean age of the survey participants and that of the SRPP sample were significantly older than that of the University as a whole, and in terms of national students' statistics liable to be even more significantly higher, however comparing the ages of BVI with sighted students and DHH with hearing showed similar age distributions.

Screen reading was generally considered in the context of BVI students, and the majority of screen reader users were BVI students, but it became apparent from the survey that other students were utilising screen-reading technology too. This included students with dyslexia and mental health problems. When considering the barriers and interventions for screen reader users there is no significant different between users who are BVI or other users.

As Non-Verbal Communications (NVC) are important to DHH students the analysis of NVC was considered during the analysis process. A brief trial was undertaken of a representative section of the video recording of one of the synchronous meetings of the focus groups to assess what value this might add to the research. The outcomes from this trial did not significantly add to the findings, and the time taken for the analysis was untenable with limited duration between live sessions, so this was not pursued. It remains an area of potential interest and may prove useful in subsequent studies.

The learning platform in use at the Open University at the time of the first study restricted the possibilities for the session format identified as an element in the Activity and Session Design category. These learning platforms have evolved as a result of the pandemic and some accessibility aspects that were not available at the time are now available in some of the collaborative environments now in use. Teams was used rather than Adobe Connect (the default tutorial platform) for the focus groups as it enabled customisation including live captioning, and personal settings. This continues to evolve and now includes aspects such as live transcription allowing history to be read (as suggested by Kushalnagar et al., (2013)), gives more flexibility in the possible layouts, much better screen reading consistency and access.

The main research question (RQ1) has been addressed by this research, suggesting we can improve inclusivity in online collaborative learning for students with sensory impairments, with barriers identified (RQ2) through student surveys and interviews, interventions proposed through the staff interviews and workshops (RQ3), contributing to a collaboratively designed and developed framework and model.

This research builds on prior research outlined in the literature review. The use of a DBR iterative approach in context with all participants makes it more comprehensive, inclusive, and robust than anything previous. Preceding research around sensory impairment in HE has not recognised the diversity of this group or their needs. With the active and collaborative participation of both students and staff with different experiences of sensory impairment, and in using an interactive approach which built towards the final model, DBR was effective in addressing the variety of barriers experienced and interventions needed.

8 Conclusions

The previous chapter, Discussion, reflected and contextualised the findings of this research. This chapter recaps on the main findings and reports on the trialling of the model, the theoretical, practical, and methodological contributions this research has made, its limitations, and possible future work arising.

8.1 Implications of Main Findings

The findings established that online synchronous collaborative learning events provide significant barriers for sensory impaired students. By using a Design-Based Research methodological approach a framework for attempting to reduce these barriers and suggest possible interventions was developed. This framework presented the components required for an effective online synchronous collaborative learning environment in the model of an interactive website. The strength in the framework and model lies in its production as part of a collaborative, iterative process with joint input from all stakeholders, but particularly the SI students who were involved throughout. The means of developing the model utilised the users, context, and environment being explored so that the research took place in context. The use of DBR allowed practical and theoretical contributions to be developed and evaluated in an iterative design process.

The four categories in MACE cover the breadth of areas that need to be considered. Inclusion extends far further that just enabling communication. Emotional and engagement factors need to be taken on board so that students feel confident and prepared for collaboration. The infrastructure and support systems need to be in place within an institution before truly inclusive learning can take place. Staff need to be supported in developing the skills and resources to implement this and to design and produce accessible inclusive materials and activities.

When all four of these categories are in place, we can have an effective, inclusive, collaborative learning environment. Students will be able to communicate effectively and in the ways that they are most comfortable with. They will have a learning environment that they are familiar with, where they feel supported and part of the student group. This environment will be one that does not place any additional stress or cognitive load on a student to participate in. Provisioning and technical factors will be in place so that there is linked up thinking and core training for all staff in making these environments accessible and inclusive. The design of these sessions will have inclusivity and accessibility in place from the foundations upwards: accessible materials and activities available to students when and in the formats they need them, with learning environments formatted and arranged in ways to positively encourage participation.

8.2 Trialling of Model

A small trial of the model was undertaken with users not participating in the original research. This was intended to get some initial feedback from the model with a view to designing a full evaluation to follow. For the evaluation I approached the OUSA and the DSG and two tutors who had not previously been involved in the research. They were provided with the model, and a short (2 minute) video with captioning and transcript explaining the purpose and use of the model. They were then asked to explore it in their own time and a short interview was conducted in order to follow this up.

Initial feedback was positive, and a few points arose from the brief interviews:

- The weighting of each factor was questioned with the suggestion that this might be different for different users.
  Response: This is something that needs to be considered and the purpose for including it evaluated. It may be that the weighting of each factor is an ongoing adjustment that could potentially be reactive to the use of the model and on-going feedback.
- Questions were asked about the usefulness of the model in a wider context i.e. other disabilities, the general student population.
  Response: The model, though focussing on sensory impairment as the subject of the research, is designed and envisage to be applicable to all students. When used in a wider context other potential barriers and areas of investigation may arise, but it is hoped that trialling the model in a similar DBR approach with the active participation of users, would bring these to light.
- It was suggested that a summary diagram or table could be provided to show all the different factors at a glance.
  Response: This is being produced.

The general response was that they could see it providing a useful tool for learning for both staff and students.

8.3 Contributions

MACE as a model addresses the shortcomings of current provisioning for SI students' participation in online synchronous collaborative learning by highlighting the problems they have identified in engaging, and offering potential solutions in terms of adjustments, training, and design approaches. There is a need identified for a different approach to live events that places accessibility as a priority.

In answering the research questions, as summarised in the Discussion chapter and detailed in Findings, the in-depth precision of present research was used alongside DBR to extend and develop inclusive practice. It has done this through both practical and theoretical contributions.

In practical terms the research provides a framework visualised in the form of a model that can be used for reference for tutors, material and activity designers, students and other staff involved in the provision of distance education with online synchronous collaborative components. It sits as a tool to be used as part of a larger online or blended programme of study. With application in the real world it has the potential to be extended and it is envisaged that future iterations will have potentially wider use.

8.4 Limitations

The statistical analysis of survey responses had limitations. Because a significant proportion of the survey respondents (n=301, 92%) were sensory impaired and the number and proportion of students with no impairment (n=26, 8%) was small then comparing responses between DHH/Hearing and BVI/Sighted statistically was complex. The ‘hearing’ students did not represent the general student population as a significant proportion were BVI. Similarly, the ‘sighted’ students had a significant proportion of DHH students so there was an inherent bias in the sampling. To counteract this the four distinct groups of ‘No SI’ (n=26, 8%), ‘DHH Only’ (n=176, 53.8%), ‘BVI Only’ (n=93, 28.4%), and ‘Dual SI’ (n=32, 9.8%) were created so that an inferential statistical analysis for each of the questionnaire items could compare each group against all others. With no section of the questionnaire being compulsory there were different numbers of responses/respondents to each question further reducing the number in each group. Having more respondents with no sensory impairment providing a larger comparison group may have brought to light additional statistical differences.

The applicability of the research within other distance education online learning scenarios has not yet been tested so there is a possibility that different approaches may bring up unforeseen additional barriers or observations. Throughout the duration of this study software utilised for conferencing and collaborative learning has undergone significant developments and changes, primarily due to the pandemic. This offers potential solutions to some of the problems and issues identified and technology in general has the potential to improve aspects here. Live captioning using Artificial Intelligence (AI) is becoming more accurate and faster. Platforms such as Microsoft Teams have incorporated this into their interfaces allowing students to turn captioning on and off, and when a session is recording be able to view live captions plus the history enabling greater context for following conversation. Whilst this is still not perfect it has noticeably improved, and the mass usage of these platforms over the last couple of years has enabled software providers to learn from this usage and adapt.

The population at the Open University is diverse and may not reflect that at other institutions so this may limit the findings to some degree. There is a larger proportion of disabled students at the OU than most universities with many choosing to study in this way because of the flexibility it offers them and the accessibility options.

8.5 Future Work

This model is an ongoing development and is not envisage as a static complete model but as one that will evolve and develop over time. This expansion has to be with the collaboration of participants in order for it to prove effective and it is hoped that the model can be further trialled within the OU as a research project.

Implementing it on a module that has collaborative online learning as an assessed component would be the next step. As part of this it is hoped to integrate staff development sessions into the evaluation, implementing staff workshops and training on how to make online tutorials more inclusive and in producing accessible materials. Through this potential support networks could be established, and dissemination processes reviewed and implemented.

Gauging the success of the model could be made through feedback and comparison with previous presentation, looking at quantitative data such as learning outcomes, withdrawal rates, attendance figures, and at qualitative feedback through interviews or surveying of students and staff who participated.

This research has exciting potential for adoption and expansion and could significantly improve collaborative learning experiences for not only sensory impaired students but for all students.

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10 Appendices

(a) Survey

1 *

Consent

The focus of this study is the Open University and its collaborative activities (such as Adobe Connect tutorials, online group work and group projects).

The proposed research is concerned with online collaborative engagement and focuses on issues surrounding involving and integrating students with hearing and/or sight impairments into online synchronous group work.

- I agree to participate in this study being conducted as part of an Open University PhD research project.
- I give permission for the data collected to be used in an anonymous form in any written reports, the web, presentations and published papers relating to this study.
- I am aware that I am free to withdraw at any point and to request the destruction of any data that has been gathered from me up until the point that the data collection is complete and aggregated (31/12/2019).
- I understand the purpose of the research, as explained above, and accept the conditions for handling the data I provide.

◉ Yes ○ No

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Online Tutorials

2 Have you attended, or watched/listened to a recording of, an **online tutorial** at the OU?

☐ Attended
☐ Watched

3 If so, please tell us about your **online tutorial** experiences:

On a scale of 1 to 5, where:

1 = strongly disagree
2 = disagree
3 = neither agree nor disagree
4 = agree
5 = strongly agree

		1	2	3	4	5	N/A
I find online tutorials very helpful	◉	○	○	○	○	○	○
I prefer to watch recordings of tutorials rather than attend live sessions	◉	○	○	○	○	○	○
I find online tutorials easy to follow	◉	○	○	○	○	○	○
I prefer to listen rather than talk during online tutorials	◉	○	○	○	○	○	○
I prefer to type rather than talk during online tutorials	◉	○	○	○	○	○	○
I like to join in with discussions	◉	○	○	○	○	○	○
I like to hear what other students have to say	◉	○	○	○	○	○	○
I like to take part in activities	◉	○	○	○	○	○	○
I enjoy working with other students	◉	○	○	○	○	○	○

4 If not, what are your reasons for not attending/watching?

5 Have you had problems accessing an **online tutorial**?

○ Yes ○ No ◉ No answer

6 If YES, please explain briefly the access problems you had.

7 Do you have any further comments about **online tutorials**?

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Face to face tutorials

8 Have you attended a **face-to-face tutorial** at the OU?

Yes No No answer

9 If YES please tell us about your **face-to-face tutorial** experiences:

On a scale of 1 to 5, where:

1 = strongly disagree
2 = disagree
3 = neither agree nor disagree
4 = agree
5 = strongly agree

		1	2	3	4	5	N/A
The locations of face-to-face tutorials are convenient for me							
I find face-to-face tutorials very helpful							
I find it easier to attend online tutorials							
I find face-to-face tutorials easy to follow							
I find it easy to access face-to-face tutorials							
I like to join in with discussions							
I like to take part in activities							
I enjoy working with other students							

10 Do you have any further comments about **face-to-face tutorials**?

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Forums and Wikis

11 Have you used online **forums** at the OU? (e.g. module forums, technical forums, tutor group forums)

○ Yes ○ No ◉ No answer

12 If YES, have these been (tick all that apply):

☐ Assessed participation as part of the course work
☐ Non-assessed participation
☐ Reading posts

13 On a scale of 1 to 5 where:

1 = strongly disagree
2 = disagree
3 = neither agree nor disagree
4 = agree
5 = strongly agree

please tell us about your **forum** experiences:

		1	2	3	4	5	N/A
I like to pose questions on forums	◉	○	○	○	○	○	○
I like to answer questions on forums	◉	○	○	○	○	○	○
I like to add to discussions on forums	◉	○	○	○	○	○	○
I find forums a good source of information	◉	○	○	○	○	○	○
I prefer to get information from the module materials	◉	○	○	○	○	○	○
I prefer to get information from my tutor	◉	○	○	○	○	○	○
Forums are a good way to create links with other students	◉	○	○	○	○	○	○
Forums help me feel part of a student group	◉	○	○	○	○	○	○
I find forums difficult to navigate	◉	○	○	○	○	○	○

14 Have you used **wikis** at the OU?

○ Yes ○ No ◉ No answer

15 If YES, have these been (tick all that apply):

- ☐ Assessed contributions as part of the course work
- ☐ Non-assessed contributions
- ☐ Reading only

16 If YES, on a scale of 1 to 5 where:

1 = strongly disagree
2 = disagree
3 = neither agree nor disagree
4 = agree
5 = strongly agree

please tell us about your **wiki** experiences:

		1	2	3	4	5	N/A
I enjoy producing a wiki with other students	◉	○	○	○	○	○	○
I don't like editing others work	◉	○	○	○	○	○	○
I find it difficult to edit and contribute	◉	○	○	○	○	○	○
I find the end product useful	◉	○	○	○	○	○	○
I find the process useful	◉	○	○	○	○	○	○
Producing a wiki helps consolidate ideas	◉	○	○	○	○	○	○

17 Do you have any further comments about **forums** and **wikis**?

Working with other students

18 Have you ever worked with other students on a group activity as part of your course work at the OU? (e.g. experiments, projects)

○ Yes ○ No ◉ No answer

19 If YES, on a scale of 1 to 5, where:

1 = strongly disagree
2 = disagree
3 = neither agree nor disagree
4 = agree
5 = strongly agree

please tell us about your **group work** experiences:

		1	2	3	4	5	N/A
I find group work useful	◉	○	○	○	○	○	○
I enjoy working with other students on projects	◉	○	○	○	○	○	○
I think group work is an important part of study	◉	○	○	○	○	○	○
I prefer to work on my own	◉	○	○	○	○	○	○
I avoid modules that involve group work	◉	○	○	○	○	○	○
I find it difficult to participate with group work	◉	○	○	○	○	○	○

20 Please explain any difficulties you have had with **group work**

21 Do you have any further comments about **group work**?

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About you.

In order for us to understand the problems students with hearing and/or sight loss experience it is useful for us to know your level of sight and hearing. If you would rather not answer please skip this section. If you would prefer to explain in your own words, please comment in the box at the bottom of this section.

22 How would you describe your **sight**?

Choose...

23 How would you describe your **hearing**?

Choose...

24 Tick any of the following that apply:

- ☐ I use British Sign Language
- ☐ I use Braille
- ☐ I lip read

25 Do you use any of the following assistive technologies? (tick all that apply):

- ☐ Dragon
- ☐ DAISY talking book
- ☐ Windows Narrator
- ☐ Mac VoiceOver
- ☐ JAWS
- ☐ NVDA,
- ☐ Dolphin Screen Reader
- ☐ System Access.
- ☐ iPhone VoiceOver;
- ☐ Android TalkBack.
- ☐ Other (please specify below)

26 Other tool(s):

Note: Selections for questions 22 and 23 are as indicated in Appendix (b) IDs 60 and 61 respectively.

27 If you have a visual and/or hearing impairment have you had any problems accessing the services and tools you need for your study at the OU?

○ Yes ○ No ◉ No answer

28 If YES please explain.

29 Tick all that apply.

Have you experienced difficulties in attending tutorials or joining in group activities relating to your:

- ☐ Sight
- ☐ Hearing
- ☐ Use of assistive technology
- ☐ Other

30 If so please briefly explain the problems.

31 Please add any additional comments on your hearing/sight impairment here if you want to:

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...and finally

32 What questions do you think we should be asking about experiences of students with hearing and/or sight impairment?

33 Is there anything else you would like to add?

Follow up interviews

We would like to conduct short follow up interviews with some respondents. If you are interested in helping this research with a follow-up interview then please provide a name and contact email. We can give interviewees a **£20 Amazon voucher** to compensate for your time. Your responses will remain anonymous. 🙂

34 Name:

35 Email:

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<< Previous Page   Submit questionnaire

(b) Full Survey and SRPP Data Fields

Table 71 Full Survey and SRPP Data Fields

Survey Data					
ID	QP	QN	Question	Responses	Data Type
1	1	1	Consent	N = 0, Y = 1	Numeric
	2		*Have you attended, or watched/listened to a recording of an **online tutorial** at the OU?*		
2		2	Attended	N = 0, Y =1	Numeric
3		2	Watched	N = 0, Y =1	Numeric
		3	*If so, please tell us about your **online tutorial** experiences:*		
4			I find online tutorials very helpful	Likert	Numeric
5			I prefer to watch recordings of tutorials rather than attend live sessions	Likert	Numeric
6			I find online tutorials easy to follow	Likert	Numeric
7			I prefer to listen rather than talk during online tutorials	Likert	Numeric
8			I prefer to type rather than talk during online tutorials	Likert	Numeric
9			I like to join in with discussions	Likert	Numeric
10			I like to hear what other students have to say	Likert	Numeric
11			I like to take part in activities	Likert	Numeric
12			I enjoy working with other students	Likert	Numeric
13		4	If not, what are your reasons for not attending/watching?	Text	Text
14		5	Have you had problems accessing an online tutorial?	N = 0, Y = 1, No answer = -99	
15		6	If YES, please explain briefly the access problems you had.	Text	Text

16		7	Do you have any further comments about online tutorials?	Text	Text
17	3	8	Have you attended a face-to-face tutorial at the OU?	N = 0, Y = 1, No answer = -99	Numeric
			*If YES please tell us about your **face-to-face tutorial** experiences:*		
18		9	The locations of face-to-face tutorials are convenient for me	Likert	Numeric
19			I find face-to-face tutorials very helpful	Likert	Numeric
20			I find it easier to attend online tutorials	Likert	Numeric
21			I find face-to-face tutorials easy to follow	Likert	Numeric
22			I find it easy to access face-to-face tutorials	Likert	Numeric
23			I like to join in with discussions	Likert	Numeric
24			I like to take part in activities	Likert	Numeric
25			I enjoy working with other students	Likert	Numeric
26		10	Do you have any further comments about face-to-face tutorials?	Text	Text
27	4	11	Have you used online forums at the OU? (e.g. module forums, technical forums, tutor group forums)	N = 0, Y = 1, No answer = -99	Numeric
			If YES, have these been (tick all that apply)		
28		12	Assessed participation as part of a course	N = 0, Y = 1, No answer = -99	Numeric
29			Non-assessed participation	N = 0, Y = 1 No answer = -99	Numeric
30			Reading posts	N = 0, Y = 1 No answer = -99	Numeric
			Tell us about your forum experiences		

31		13	I like to pose questions on forums	Likert	Numeric
32			I like to answer questions on forums	Likert	Numeric
33			I like to add to discussions on forums	Likert	Numeric
34			I find forums a good source of information	Likert	Numeric
35			I prefer to get information from the module materials	Likert	Numeric
36			I prefer to get information from my tutor	Likert	Numeric
37			Forums are a good way to create links with other students	Likert	Numeric
38			Forums help me feel part of a student group	Likert	Numeric
39			I find forums difficult to navigate	Likert	Numeric
40		14	Have you used wikis at the OU?	N = 0, Y = 1 No answer = -99	Numeric
			If YES, have these been (tick all that apply):		
41		15	Assessed contribution as part of the course work	N = 0, Y = 1 No answer = -99	Numeric
42			Non-assessed contributions	N = 0, Y = 1 No answer = -99	Numeric
43			Reading only	N = 0, Y = 1 No answer = -99	Numeric
			*Please tell us about your **wiki** experiences:*		
44		16	I enjoy producing a wiki with other students	Likert	Numeric
45			I don’t like editing others work	Likert	Numeric
46			I find it difficult to edit and contribute	Likert	Numeric
47			I find the end product useful	Likert	Numeric

48			I find the process useful	Likert	Numeric
49			Producing a wiki helps consolidate ideas	Likert	Numeric
50		17	Do you have any further comments about forums and wikis?	Text	Text
51	5	18	Have you ever worked with other students on a group activity as part of your course work at the OU? (e.g. experiments, projects)	N = 0, Y = 1 No answer = -99	Numeric
			Please tell us about your **group work** experiences:		
52		19	I find group work useful	Likert	Numeric
53			I enjoy working with other students on projects	Likert	Numeric
54			I think group work is an important part of study	Likert	Numeric
55			I prefer to work on my own	Likert	Numeric
56			I avoid modules that involve group work	Likert	Numeric
57			I find it difficult to participate with group work	Likert	Numeric
58		20	Please explain any difficulties you have had with group work	Text	Text
59		21	Do you have any further comments about group work?	Text	Text
60	6	22	How would you describe your sight?	1 = Perfect vision 2 = Generally OK 3 = Corrected by glasses 4 = Partially corrected by glasses 5 = Limited vision 6 = Blind	Numeric
61		23	How would you describe your hearing?	1 = Perfect hearing 2 = Generally OK	Numeric

				3 = Hearing problems in some environments 4 = Corrected by hearing aid 5 = Partially corrected by hearing aid 6 = Limited hearing 7 = Deaf	
			Tick any of the following that apply:		
62		24	I use British Sign Language	N = 0, Y = 1	
63			I use Braille	N = 0, Y = 1	
64			I lip read	N = 0, Y = 1	
			Do you use any of the following assistive technologies? (tick all that apply)		
65		25	Dragon	N = 0, Y = 1	
66			DAISY	N = 0, Y = 1	
67			Windows Narrator	N = 0, Y = 1	
68			Mac VoiceOver	N = 0, Y = 1	
69			JAWS	N = 0, Y = 1	
70			NVDA	N = 0, Y = 1	
71			Dolphin Screen Reader	N = 0, Y = 1	
72			System Access	N = 0, Y = 1	
73			iPhone VoiceOver	N = 0, Y = 1	
74			Android TalkBack	N = 0, Y = 1	
75			Other (specify below)	N = 0, Y = 1	

76			Other tools	Text	Text
77		27	If you have a visual and/or hearing impairment have you had any problems accessing the services and tools you need for your study at the OU?	N = 0, Y = 1 No answer = -99	Numeric
78		28	If YES please explain	Text	Text
			Tick all that apply. Have you experienced difficulties in attending tutorials or joining in group activities relating to your:		
79		29	Sight	N = 0, Y = 1	Numeric
80			Hearing	N = 0, Y = 1	Numeric
81			Use of assistive technology	N = 0, Y = 1	Numeric
82			Other	N = 0, Y = 1	Numeric
83		30	If so please briefly explain the problems	Text	Text
84		31	Please add any additional comments on your hearing/sight impairment here if you want to	Text	Text
85	7	32	What questions do you think we should be asking about experiences of students with hearing and/or sight impairment?	Text	Text
86		33	Is there anything else you would like to add?	Text	Text
			Follow up interviews		
87		34	Name	Text	Text
88		35	Email address	Text	Text
89			Age	Years	Numeric
90			Detailed age	1 = 21 and under 2 = 22-24 3 = 25-29 4 = 30-39	Numeric

				5 = 40-49 6 = 50-59 7 = 60-64 8 = 65 and over	
91			Grouped age	1 = Under 25 2 = 26-35 3 = 36-45 4 = 46-55 5 = 56 and over	Numeric
92			Sex	Female = 1, Male = 2	Numeric
93			Ethnicity	1 = Asian 2 = Black 3 = Mixed 4 = Other 5 = Refused 6 = White	Numeric
94			Registered sensory impaired	0 = No, Y = 1	
95			Grouped education	1 = No Formal Qualifications 2 = Less than A Levels 3 = A Levels or equivalent 4 = HE Qualification 5 = PG Qualification 6 = Not known	

96			Region	1 = E. Midlands 2 = East of England 3 = London 4 = N. Ireland 5 = N. West 6 = North 7 = Scotland 8 = South 9 = South East 10 = South West 11 = W. Midlands 12 = Wales 13 = Yorkshire	
97			Declared disability	0 = No disability declared 1 = Disability Declared	
98			Autistic spectrum	0 = No, Y = 1	
99			Fatigue and Pain	0 = No, Y = 1	
100			Hearing	0 = No, Y = 1	
101			Manual Skills	0 = No, Y = 1	
102			Mental Health	0 = No, Y = 1	
103			Mobility	0 = No, Y = 1	
104			Personal Care	0 = No, Y = 1	
105			Sight	0 = No, Y = 1	

106			Specific e.g. Dyslexia	0 = No, Y = 1	
107			Speech	0 = No, Y = 1	
108			Unseen disability	0 = No, Y = 1	
109			Occupational Status	1 = Doing unpaid voluntary work 2 = In full-time work/self-employed 3 = In part-time work/self-employed 4 = Information Refused 5 = Looking after the home/family 6 = Not in paid work for some other reason 7 = Not Known 8 = Retired from paid work 9 = Unable to work: long-term sickness/disability 10 = Unemployed and looking for a job	
110			Qualification Intention	0 = No, Y = 1	
111			Faculty	FASS = Faculty of Arts and Social Sciences FBL = Faculty of Business and Law LTI = Learning and Teaching Innovation STEM = Faculty of Science, Technology, Engineering and Maths	

				WELS = Faculty of Wellbeing, Education and Languages Studies	
Derived Data					
112			VL (Visual Level) – Sighted is where the values for ID 60 = 1 – 3, VI (Visual Impairment) is where the values for ID 60 >= 4, NA is where no answer was given.	NA, VI, Sighted	
113			HL (Hearing Level) – Hearing is where the values for ID 61 = 1 or 3, DHH is where the value for ID 61 >= 3, NA is where no answer was given.	NA, DHH, Hearing	
114			VLG (Visual Level Group) – Those with NA for ID 60 but 1 for ID 105 have been added to the VI group.	NA, VI, Sighted	
115			HLG (Hearing Level Grou) – Those with NA for ID 61 but 1 for ID 100 have been added to the HL group	NA, DHH, Hearing	

Notes

- ID this is a unique identified given to each field of data and fields are referenced by this ID in the findings.
- QP Indicates the page on the questionnaire (see appendix)
- QN indicates the question number on the survey (see appendix)

All Likert scales are:

- strongly disagree
- disagree
- neither agree nor disagree
- agree
- strongly agree

(c) Survey Invitation Email

Subject: Improving access to online group work and tutorials / hearing and sight impairment

We are conducting research into improving student access to online group work and would really value input from as many students as possible. We are interested in your experiences and thoughts about collaboration, and the tools and activities used at the Open University.

This study is part of the research by Jo Buxton for her PhD. The focus of this study is collaborative activities such as Adobe Connect tutorials, online group work and group projects.

The research is focused on issues surrounding involving and integrating students with hearing and/or sight impairments into online synchronous group work. It is hoped that this will result in more accessible, inclusive online activities that will benefit all students.

If you could complete the online questionnaire using the link below, this would be greatly appreciated. Responses will only be used in an anonymous form, and no personal data will be shared.

https://learn1.open.ac.uk/mod/questionnaire/view.php?id=21670

Thank you in advance.

Jo Buxton, Open University
Email: jo.buxton@open.ac.uk.
Alternative Contact: Dr Tim Coughlan (Supervisor)
Email: tim.coughlan@open.ac.uk

About this interview

This interview is for my research at the Open University '*Design for Accessible Collaborative Engagement: Can we improve inclusivity in collaborative learning for students with sensory impairments*?' This is part of a pilot study to help get a broad understanding of the issues. I'm trying to get the opinions of the various different groups involved so: students, tutors, academics, modules teams.

You are free to leave or withdraw at any time.

About You

- Can you give me a bit of background as to your journey at the OU?
- Tell me a bit about your current study at the OU.
- What modules are you currently studying?
- Do any of these include group work? Is this assessed?
- What is your personal level of hearing and sight?
- What assistive technologies, if any, do you use?

Your Experiences

- Can you tell me about any positive experiences you have had at the OU relating to sensory impairment?
- Can you tell me about any negative experiences you have had at the OU relating to sensory impairment?
- Have you participated in any online collaborative work at the OU? If so:
    - Were there any technical issues that affected your involvement?
    - Where there any non-technical issues?
    - How did you find the experience?
    - Were other participants aware of your disabilities from the start? If not when? (if at all).
- Tell me about your online experiences in relation to:
    - Working with other students/staff members
    - The activities you were asked to perform
    - The learning outcome: did you feel this contributed to your learning/understanding?
- Are there specific issues you have noticed with Adobe Connect that you haven't mentioned?
- Are there any specific problems relating to the modules you currently on?

Your understanding of others' experiences

- How typical do you think the issues you have encountered are for other students with sensory impairment?
- Can you give me any examples of student issues relating to sensory impairment that you have dealt with?
- What questions do you think we should be asking students in this context (collaboration/sensory impairment)?

Any other questions, or things you would like to add?

(d) Interview Information Sheet

This sheet provides information on the study '*Design for inclusive collaborative engagement: can we improve inclusivity in collaborative learning for students with sensory impairments?*'

This study is part of the research by Jo Buxton for her PhD and is taking place at the Open University. We are looking into improving access and overcoming barriers to online collaborative activities such as Adobe Connect tutorials, online group work and group projects.

We can't do this without you and your input will be tremendously helpful to this study. In return we hope that we can come up with ways to enhance your experiences of online activities such as tutorials and group work.

We need to understand what the barriers are, and we are particularly focussing on students with hearing and/or sight impairments as there seems to be additional barriers for students in these groups.

With the help of input from students and staff we are then intending to look at what interventions we can design to help to overcome these barriers. These might be technical solutions, better training or information for staff, ways to improve communication, or changes to activity design. We'd like to involve students throughout the whole process because your voice is important to us. Your experiences, thoughts and suggestions are invaluable!

If you could help by agreeing to be interviewed it will be an enormous contribution to my study. A consent form is provided. Your contributions will be anonymous, and you can withdraw at any time. If you would like to be involved, please fill in the form and return it to me by email.

If you have any questions or would like further information then please feel free to contact me.

Thank you in advance. I look forward to hearing back from you.

Jo Buxton, Open University

Email: jo.buxton@open.ac.uk.

Alternative Contact: Dr Tim Coughlan (Supervisor)

Email: tim.coughlan@open.ac.uk

(e) HREC

Section Three: About your research

3.1 What is the purpose of your research and what are your objectives? Please explain in brief. Remember to explicitly state the research questions or problem you would like to solve.
Many courses at the Open University incorporate online collaborative activities intended to produce deeper learning and develop group work skills. The development of group work skills is crucial to the institutions employability agenda as these skills are highly valued by employers. Evidence from staff and student feedback, further supported by a pilot study conducted for this research, suggests students with sight and/or hearing impairments have difficulty engaging in these activities. This research intends to address the problems that students with sensory impairments[1] encounter when participating in live online group/collaborative activities. These problems can be technical, practical and/or pedagogical. For example, activities may involve collaborating on a whiteboard which is not visible to visually impaired students or assistive technologies, screen readers may be talking over presenters or current speakers, delayed communications such as BSL translation can make it difficult to engage in the flow of conversation, and the need for self-advocacy – making others group members aware of adjustments needed – can be inhibiting. The research questions this study intends to address are: RQ1: How do we improve inclusivity in synchronous online collaborative learning for students with sensory impairments? RQ2: What are the barriers to engagement for collaborative activities? RQ3: What interventions can we design that might improve inclusivity for students with sensory impairments? The goal of this research is to understand the barriers to inclusion for students with sensory impairment and provide interventions to address these barriers. This should in turn improve inclusivity for students participating in collaborative activities.

3.2 Please give a brief description of your approach and methodology. Your approach and methodology needs to be well defined and explained. You also need to demonstrate how the plans for the project and data collection methods selected and outlined will produce results which can answer their research question(s).
Overview The research will consist of two phases: • Phase 1 – identifying the barriers: student survey / interviews with all stakeholders including students and staff (RQ2) • Phase 2 – designing the interventions: a design-based research phase using a focus group to help develop, design and evaluate interventions to address the barriers. (RQ1, RQ3) **Student Studies** Phase 1 of this research will consist of an online student survey (questionnaire) followed by interviews with a proportion of respondents. Volunteers from this process will be asked (along with other non-student stakeholders) to join the focus group for phase 2. An internally hosted platform available via the Collaborative Accessible Design site (https://learn1.open.ac.uk/course/view.php?id=100182) will include forums, resources and other moodle items

[1] I use the term 'students with sensory impairment' to represent students with varying levels of hearing and/or sight impairment. This can range from blind or profoundly deaf to partial hearing or sight loss.

available on a standard OU module site. This will support the study through discussion and feedback. This also hosts the student questionnaire.

Questionnaire

The questionnaire will be aimed at students across all faculties and those with declared hearing or sight impairments are expected to form a significant proportion of targeted students/respondents. Ideally approximately 200 questionnaire responses are required so it is hoped to target approximately 2,000 students of which 60% should be those with sensory impairments.

Students will be sent an invitation email (Appendix A) during mid to late October, which will explain the reasons for the study being undertaken as well as the benefits of taking part. A link to the online questionnaire (see Appendix B) will be provided. This will include the consent statement (Appendix B, page 1) required for submission of the questionnaire. The questionnaire includes an option to take part in the second student study - the interview.

Interview

Ideally interviewees with varying levels of hearing and/or sight loss, and with experience of group work or reactions to it. If possible BSL speakers, lip-readers and braille readers will be included. Students selected for interview will be offered a £25 Amazon voucher. Interviews will be semi-structured and proposed questions and areas of discussion are covered in appendix C. Consent forms and information sheets will be provided prior to interview (appendices D and E).

Focus group

Students willing to be involved in the focus group will be asked to participate in several sessions including brainstorming, design and evaluation sessions. These will be conducted live via Adobe Connect, and via platform tools such as wikis and forums. These mediums themselves will be part of the research.

3.3 Data collection methods: Please indicate your proposed research method(s).
(Please select all that apply)

Quantitative Methods		**Qualitative Methods**	
Online survey	☒	Interview - online or face-to-face or telephone	☒
Developmental user testing	☒	Developmental user testing	☒
Other – please specify below	☐	Focus group – online or face-to-face	☒
		Other - please specify below	☐
Please specify 'Other':		Please specify 'Other'	

3.4 Detail any software or online survey tools (as applicable) you plan to use to conduct your research with your target population. *For example, for an online survey - Qualtrics or JISC Online Survey System (formerly BOS) or for an online focus group - Adobe Connect. It is important you make sure that any software or any online survey tool you plan to use for your research is compliant with OU Information Security policies or current data protection legislation as set out to students in the Student Privacy Notice*

All software and online survey tools will be via an OU Moodle site, using OU provided tools, and will be compliant with OU Information Security policies and data protection legislation.

The online survey (questionnaire) will be hosted on an OU Moodle site, using the OU Moodle tool. An OU login will be required to access the questionnaire but all responses will be processed and evaluated anonymously. The results will be published only in anonymised and aggregated forms.

Questionnaire respondents will be offered the option to be involved in follow up interviews.

In order to make the interview itself as accessible as possible an option of different formats will be offered to interviewees based on their preferred method of communication. Interviews will be conducted in the following formats:

- Adobe Connect: Voice interview
- Adobe Connect: Text chat
- Adobe Connect: Web Cam interview (lip reading support)
- Adobe Connect: Interview with BSL interpreter video support.
- Face-to-face: Voice interview
- Face-to-face: Voice interview with BSL interpreter support

If alternative options are suggested by interviewees and are viable then they will be adopted. Flexibility and accessibility are essential.

The focus group again will meet via Adobe Connect and activities, meetings and group work will be undertaken solely in the context of the moodle site.

(f) Consent Form – Focus Group

Consent form for PhD study on '*Design for inclusive collaborative engagement: can we improve inclusivity in collaborative learning for students with sensory impairments?*'

☐	I agree to participate in this study being conducted as part of an Open University PhD research project.
☐	I give permission for the data collected to be used in an anonymous form in any written reports, the web, presentations, and published papers relating to this study.
☐	I agree to the focus group being audio recorded.
☐	I agree to the focus group being video recorded.
☐	I am aware that I am free to withdraw at any point, and can ask for my contributions to be removed without having to give a reason up until the 31st December 2020. This can be done by contacting either Jo Buxton or Tim Coughlan via email (jo.buxton@open.ac.uk or tim.coughlan@open.ac.uk)
☐	I understand the purpose of the research, as explained in the information sheet provided, and accept the conditions for handling the data I provide.

Name:

Signature:

Date:

(g) Accessibility Testing the Model

The interactive website model was developed with accessibility as a primary concern. The model was tested for general accessibility using Wave, for colour blindness using Oracle Color, for general colour contrast using CCA (Colour Contrast Analyser), using a screen reader (NVDA), and using keyboard navigation. It will be further accessibility tested with SI students.

Figure 27 Example - Wave testing of MACE

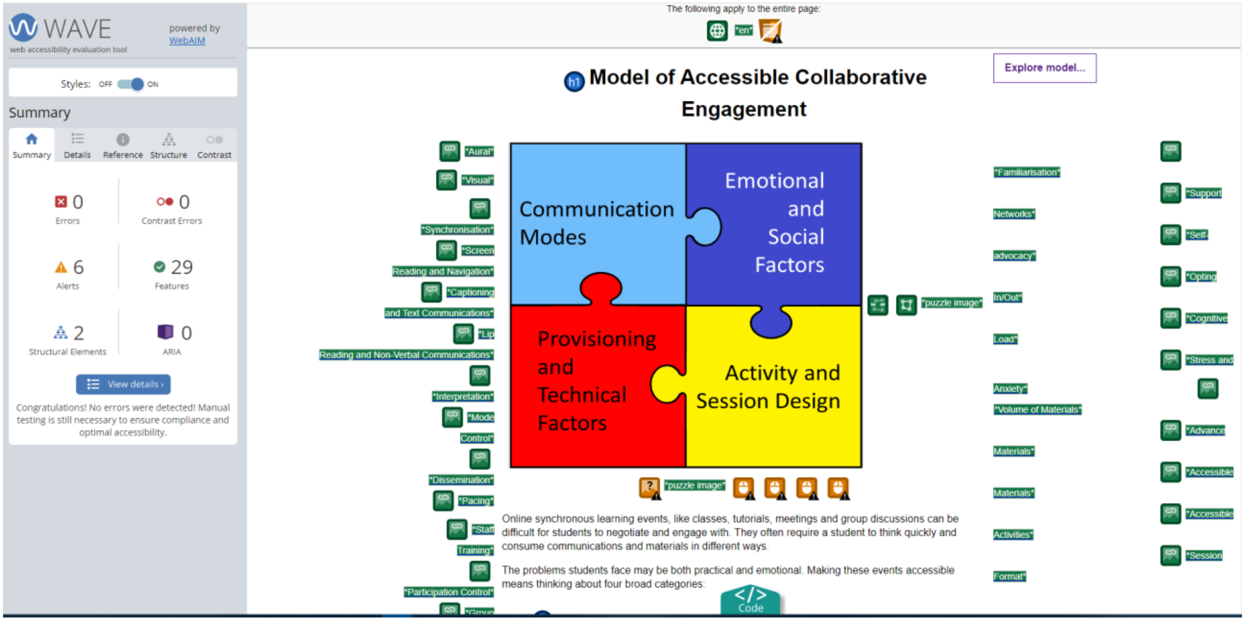


Figure 28 Example - Colour Blindness testing of MACE

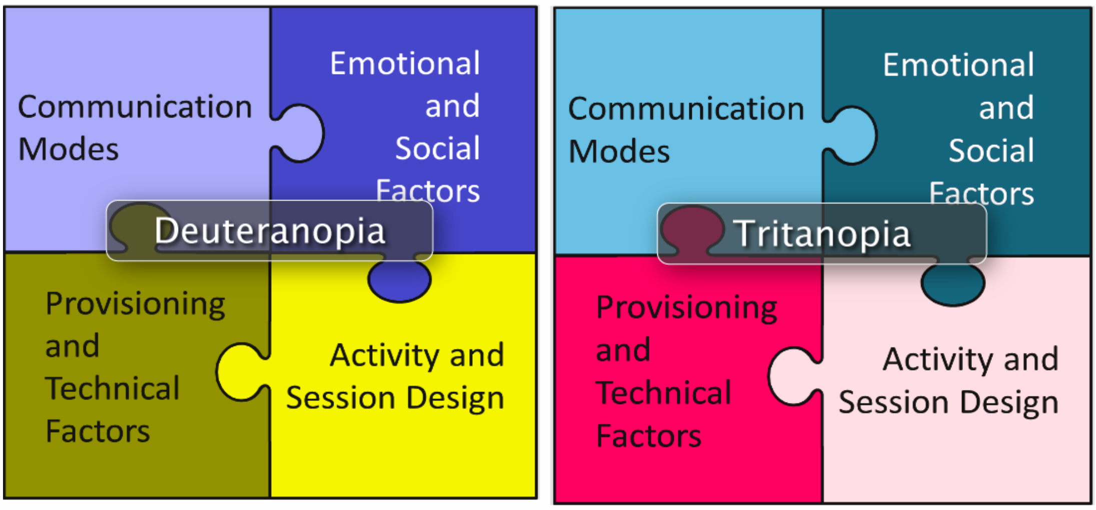
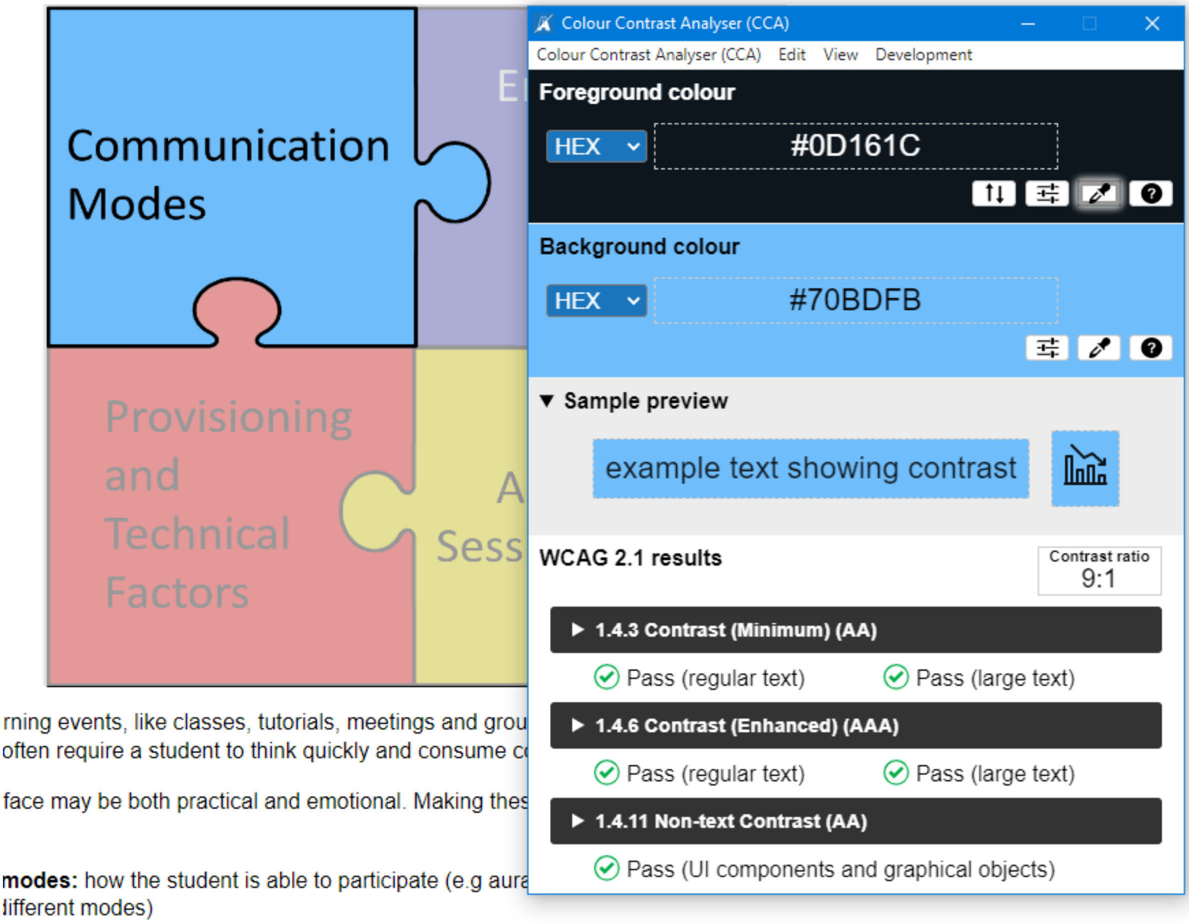


Figure 29 Example - Colour Contrast testing of MACE



(h) Literature Research – Key Phrases

Table 72 Literature Review Key Phrases

Category	Keys Words/Phrases	Synonyms/Alternatives
Sensory Impairment	DHH, BVI	Deaf, Hard of hearing, hearing impaired, hearing loss, aural, dual sensory, blind, visual impairment, loss vision, sight impaired, sight loss
Learning environments	Online, synchronous, asynchronous, face-to-face, learning environment	Live, time-independent, time-location independent, off-line, learning platform, collaborative platform, on-site, off-site, classroom, virtual classroom, learning event, e-learning, computer supported learning
Collaboration	Collaborative learning, group work	Cooperative learning, social learning, social presence, CSCL, Computer Supported Collaborative Learning, CoI, Community of Inquiry

Logged search words and phrases:

‘academic achievement’,’academic attainment’,’academic content learning’,’academic inclusion’,’academic motivation’,’academic networking’,’academic performance’,’academic progress’,’access’,’accessibility’,’accessibility audit’,’accessibility design and evaluation’,’accessibility evaluation’,’accessibility for people who are deaf or hard-of-hearing’,’accessibility guidelines’,’accessibility of education’,’accessibility technology for deaf people’,’accessibility technology for people who are deaf’,’accessible applications’,’accessible education’,’accessible interaction design’,’accident prevention’,’accommodations’,’acquired deafblindness’,’active learning’,’activism’,’activity recognition’,’adaptation tools’,’adaptive interfaces’,’adaptive language model’,’adaptive learning system’,’adaptive learning technologies’,’adaptive support’,’adaptive user interface’,’additional knowledge’,’adjunct instructional aids’,’adolescents’,’adult learning’,’alternative interface’,’alternative presentation of math structural inform’,’american sign language’,’argumentation tools’,’artificial intelligence’,’artificial intelligence in education’,’assistive devices’,’assistive technologies’,’assistive technology’,’asynchronous’,’asynchronous communication’,’asynchronous distance education’,’asynchronous interaction’,’asynchronous system’,’audio’,’audio graphs’,’auditory feedback’,’augmentative and alternative communication’,’augmentative and alternative communication (aac)’,’augmented reality’,’aural navigation’,’authentic accessibility’,’authentic activities’,’authentic learning’,’automated evaluation’,’automatic captioning’,’automatic speech recognition’,’awareness’,’baccalaureate programs’,’barriers’,’beliefs about tutoring’,’bilingual’,’bilingual education’,’blended learning’,’blind’,’blind & deaf communication’,’blind and sighted students’,’blind people’,’blind student’,’blind students’,’blind users’,’blind/low vision’,’blindness’,’braille’,’camera’,’campus-wide information systems’,’capabilities approach’,’caption understandability evaluation’,’captioning’,’captions’,’classroom’,’classroom practice’,’classroom research’,’cochlear implants’,’co-design’,’cognitive engagement’,’cognitive impairment’,’cognitive interaction’,’cognitive load’,’cognitive presence’,’cognitive tools’,’collaboration’,’collaborative activities’,’collaborative group’,’collaborative learning’,’collaborative learning (cl)’,’collaborative learning model’,’collaborative learning style’,’collaborative online learning’,’collaborative online learning environment’,’collaborative online practices’,’collaborative practice’,’collaborative systems’,’collaborative technology’,’collaborative/cooperative learning’,’collision avoidance’,’color blindness’,’color differentiation’,’color perception’,’color vision deficiency (cvd)’,’communication’,’communication in education’,’communication preferences’,’communication skills’,’communicative skills’,’community of inquiry’,’community of practice’,’computer interface’,’computer supported collaborative learning’,’computer-mediated collaborative work’,’computer-mediated communication’,’computers’,’computers and learning’,’computer-supported collaborative learning’,’computer-supported collaborative learning (cscl)’,’conceptions of tutoring’,’concurrent speech’,’consultation’,’content adaptation’,’content meta-analysis’,’content personalization’,’continuum of solutions’,’control’,’conversational narrative’,’conversational user interfaces’,’cooperation scripts’,’cooperative learning’,’cooperative/collaborative learning’,’co-regulation’,’coteaching’,’course satisfaction’,’cscl’,’cscl methodology’,’cscl theory’,’cscl tools’,’culture’,’deaf’,’deaf and blind individuals’,’deaf and hard of hearing’,’deaf and hard of hearing students’,’deaf and hard-of-hearing’,’deaf and hard-of-hearing children’,’deaf and hard-of-hearing students’,’deaf children’,’deaf communication’,’deaf education’,’deaf learners’,’deaf literacy’,’deaf or hard-of-hearing’,’deaf people’,’deaf students’,’deaf students with disabilities’,’deaf with additional disabilities’,’deaf with disabilities’,’deaf with multiple disabilities’,’deaf/hard of hearing’,’deafblind’,’deaf-centered e-learning environment’,’deafness’,’deafplus’,’deep learning’,’deep processing’,’design based research’,’design case’,’design evaluation’,’design for all’,’design of learning environments’,’design paradigm’,’design principles’,’design research’,’design science research’,’design-based research ‘,’design-based research (dbr)’,’design-for-all-process’,’dhh’,’diagram’,’dialogical interactions’,’digital accessibility’,’digital education’,’digital technologies’,’digital transformation’,’directed learning’,’disabilities’,’disability’,’disability discrimination act’,’disability rights’,’disability services’,’disability support services’,’disabled peoples' movement’,’disabled students’,’disablement’,’disabling barriers’,’disadvantaged students’,’disclosure’,’discourse’,’discourse structure’,’discrimination’,’discussion boards’,’discussion forums’,’disruption of conventional learning’,’distance education’,’distance education and online learning’,’distance education and telelearning’,’distance learning’,’distance learning and telelearning’,’distributed cognition’,’distributed learning’,’distributed learning environments’,’diversity’,’e-assessment’,’education for people with special needs’,’educational data mining’,’educational fads’,’educational games’,’educational impact’,’educational levels’,’educational psychology’,’educational software’,’educational support’,’educational technologies’,’educational technology’,’e-learners’,’elearning’,’e-learning’,’embodiment’,’emergency remote teaching’,’emergency transition’,’emotional engagement’,’empathy’,’employment’,’empowerment’,’emulation software’,’engagement’,’engaging students’,’enhanced learning’,’expressive communication’,’eye tracking’,’eyetracking’,’eye-tracking’,’face-to-face tutorial support’,’facial expression’,’facilitation’,’flipped learning’,’foci of attention’,’focus groups’,’for-cognitive disability’,’for-deaf’,’for-hearing disability’,’format adaptations’,’for-speech disability’,’for-visual disability’,’general education classrooms’,’gesture-based interfaces’,’grounded design’,’group practice’,’group projects’,’group tension’,’group transformation’,’group tuition’,’group work’,’group-as-a-whole’,’haptic’,’haptic interface’,’haptic user interfaces’,’hard of hearing’,’hard-of-hearing’,’hard-of-hearing students’,’hartmanis’,’hearing aids’,’hearing impaired’,’hearing impairment’,’hearing impairment computer aid’,’hearing loss’,’heuristic evaluation’,’higher education’,’higher educational institutions’,’higher order thinking skills’,’history’,’history of online education’,’human’,’human computer interaction’,’human factors’,’human multi-tasking’,’human resource management’,’human-centred design’,’human-computer interaction’,’ict’,’ict for deaf students’,’identification’,’identity’,’identity presence’,’identity salience’,’image-based system’,’impairment’,’inclusion’,’inclusion research’,’inclusive classrooms’,’inclusive design’,’inclusive education’,’inclusive education policy’,’inclusive e-learning’,’inclusive learning’,’inclusive learning environments’,’inclusive practice’,’inclusive school’,’individual characteristics’,’individual differences’,’individual model’,’induction’,’informal learning’,’informal learning environments’,’information and communication technologies (icts)’,’information dissemination’,’information environment’,’information exchanges’,’information graphics’,’information overload’,’information processing’,’inquiry-based learning’,’instructional design’,’instructional systems design’,’instructional technology’,’instructor scaffolding’,’instructor-led’,’interaction’,’interaction design’,’interaction effect’,’interactions’,’interactive’,’interactive learning environments’,’interactive simulations’,’interactivity’,’interdisciplinary research’,’interface design’,’internet’,’internet in education’,’internet self-efficacy’,’interpreter’,’intervention’,’interventions studies’,’invisible disabilities’,’language development’,’language generation’,’language-independent’,’large scale learning’,’learner agency’,’learner-centred’,’learning analytics’,’learning behaviors’,’learning communities’,’learning design’,’learning disabilities’,’learning disability’,’learning environment’,’learning environment or tool’,’learning environments’,’learning expectations’,’learning management systems’,’learning patterns’,’learning performance’,’learning strategies’,’learning styles’,’learning technologies’,’learning theory’,’learning-related anxiety’,’lip-reading’,’literature review’,’literature reviews’,’live subtitling’,’low vision’,’machine learning’,’mainstream’,’media accessibility’,’media in education’,’mental representation’,’mentoring’,’mentors’,’meta-analysis’,’middle school students’,’military’,’mobile learning’,’mobile technology’,’mobile video conferencing’,’mobile web’,’mobile web browser’,’modality-specific’,’monitoring accessibility’,’mooc’,’moocs’,’motivation’,’multilingual’,’multimedia’,’multimodal’,’multimodal discourse analysis’,’multiple audio sources’,’multiple speakers’,’multi-process learning’,’multi-user virtual environments’,’mutual obligation’,’negative feedback’,’nonverbal communication’,’non-verbal communication’,’non-verbal vocal interface’,’online’,’online behavior’,’online collaborative learning','online community','online discourse analysis','online discussion','online distance learning','online education','online higher education','online instruction','online interactions','online knowledge building','online language learning','online learning','online learning community','online learning environment','online participation','online pedagogy','online search','online social networks','online staff development','online student readiness','online teacher preparation','online teaching and learning','online tuition','online tutorial support','online-course template','open education practices','open learning','open university','pandemic','participation motivation','participatory activities','participatory analysis','participatory and social dimensions','participatory design','participatory learning','participatory research','participatory task modelling','partnership','patient-centered','pauses in audiodescription','pedagogical challenges','pedagogical issues','pedagogical practice','pedagogy','peer learning','people with disabilities','perceived learning','personal narrative','personal theories of learning','post-compulsory education','postsecondary','postsecondary accommodations','postsecondary education','post-secondary education','predictive keyboard','problem-based learning','problem-based learning objects','program evaluation','programming','qualitative data analysis','quality communication','quality matters','quantitative analysis','quasi-experimental analysis','read alouds','readability','reading disability','real-time','real-time captioning system','real-time captions','real-time human computation','real-time}','real-world accessibility','reconstruction of knowledge','remote tutoring','research','research design','research designs','research methodology','research methodology ','research methods','research paradigms and design-based','research processes','research settings','research through design','research utilization','research-based instruction','role of the instructor','satisfaction','scaffolding','scanning','scholarly websites','scholarship of teaching and learning','screen reader','self perception','self-advocacy','self-determination','self-determination theory','self-directed learning','self-regulated learning','self-regulation','sen','sense of control','sensory impairment','sensory substitution','shared knowledge','sighted','sign language','sign language processing','sign language recognition','sign language synthesis','sign language translator','sign language video','sign languages','signed language','simultaneous speech','situated learning','situational impairment','social accessibility','social behavior','social collaborative learning environment','social comparison','social exchange balance','social factors','social inclusion','social integration','social interactions','social learning','social learning styles','social media','social media in education','social model','social network analysis','social networking sites}','social phenomenology','social presence','social technologies','socially shared regulation of learning','sociocognitive perspective}','sonifications','spatial audio','spatial sound','speech','speech output','speech perception','speech recognition','student engagement','student expectations','student interactions','student learning','student motivation','student perceptions','student success','student teachers','student-centered learning','students' interactions','students' involvement','students learning outcomes','students' satisfaction','students with disabilities','students with visual impairment','subtitling for the deaf','surface processing','synchronous','synchronous and asynchronous','synchronous communication','synchronous distance education','synchronous e-learning','synchronous interaction','synchronous learning activities','synchronous online learning','synchronous online teaching','synchronous system','tactile','tactile images','task representation','task-based design','teacher','teacher behaviour','teacher development','teacher of the deaf','teacher perceptions','teacher skills','teacher training','teachers assistants','teacher's support','teachers}','teaching','teaching and learning','teaching assistants}','teaching methods','teaching or learning strategies','teaching presence','teaching strategies','teaching/learning strategies','teaching/learning strategies}','team dynamics','teamwork satisfaction','technological affordances','technological challenges','technological tools','technology','technology adoption','technology for collaborative learning','technology-enhanced learning','telecollaboration','tertiary education','text','text input','text messaging','text simplification','text-entry','textual interaction','the role of nonverbal','thematic analysis','thematic data analysis','thinking styles','touch screens','transactional distance','transactional engagement','transcoding','transcripts','transition','transition planning services in}','transition services','translanguaging','tutor perceptions','tutoring aids','udl','universal design','universal design for learning','universal design for learning (udl)','universal screening','universalism','university','usability','usability tests','user experience','user experience (ux)','user-interfaces','video accessibility','video enrichment','videoconferencing','virtual assistants','virtual classroom','virtual classrooms','virtual environments','virtual group development}','virtual learning','virtual learning environments','vision impaired users','visual','visual analysis','visual disability','visual education','visual feedback','visual impairment','visual scaffolding','visual sources','visualization of participation','visualization tools','visually and hearing impaired','visually impaired','visually impaired people}','visually impaired students','visuospatial attention','visuospatial cognition','vnc','voice-based augmentation','web accessibility','web conferencing','web navigation','web-based','web-based instruction','web-based teaching and learning','website adaptation techniques','web-videoconference','wiki','wikipedia','workplace technology'