

Creating ‘a simple conversation’: Designing a conversational user interface to improve the experience of accessing support for study

Designing a conversational user interface

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Administrative processes are ubiquitous in modern life and have been identified as a particular burden to those with accessibility needs. Students who have accessibility needs often have to understand guidance, fill in complex forms and communicate with multiple parties to disclose disabilities and access appropriate support. Conversational user interfaces (CUIs) could allow us to reimagine such processes, yet there is currently limited understanding of how to design these to be accessible, or whether such an approach would be preferred. In the ADMINS (Assistants for the Disclosure and Management of Information about Needs and Support) project, we implemented a virtual assistant (VA) which is designed to enable students to disclose disabilities and to provide guidance and suggestions about appropriate support. ADMINS explores the potential of CUIs to reduce administrative burden and improve the experience of arranging support by replacing a static form with written or spoken dialogue. This paper reports the results of two trials conducted during the project. A beta trial using an early version of the VA provided understanding of accessibility challenges and issues in user experience. The beta trial sample included 22 students who had already disclosed

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disabilities and 3 disability support advisors. After improvements to the design, a larger main trial was conducted with 134 students who disclosed their disabilities to the university using both the VA and the existing form-based process. The results show that the VA was preferred by most participants to completing the form (64.2% vs 24.6%). Qualitative and quantitative feedback from the trials also identified accessibility and user experience barriers for improving CUI design, and an understanding of benefits and preferences that can inform further development of accessible CUIs for this design space.

CCS CONCEPTS • Computing methodologies • Intelligent agents • Information systems • Expert systems • Social and professional topics • People with disabilities

Additional Keywords and Phrases: Conversational user interfaces, chatbots, virtual assistants, artificial intelligence, accessibility, user experience, trial

INTRODUCTION

Literature suggests that conversational user interfaces (CUIs) present opportunities for users with accessibility needs [3, 50]. CUIs can perform tasks for users through text-based chat or by interpreting human speech and responding via synthesised voices. This can allow flexibility, personalisation of the experience and alternative modes of communication [39]. CUIs could enable more efficient and effective access to support for people with accessibility needs. However, there is little research to date that explores how to design CUIs to be accessible [44, 46], or how best to use them to support people with accessibility needs [31].

This research explores the potential of CUIs to improve the experience of disclosing disabilities and accessing support in the context of tertiary education. Our prior research with students has highlighted the impacts these kinds of administrative processes have on students, including stress, reduced time to focus on study, and delays in getting the right support [8]. To explore how CUIs could be used in response, we developed and trialled a disability disclosure virtual assistant (VA) that supports written and spoken dialogue, as an alternative to an existing static HTML form used by students in the disclosure process. We focus our evaluation on whether and how this CUI could be an improvement over the form, and how such a system can be designed to be accessible to the widest audience of users with accessibility needs.

This research was conducted at the Open University (OU), UK. The OU is a distance learning university in the UK which currently supports more than 20,000 students who have declared disabilities. Generally, the OU uses a combination of online forms and conversations with advisors to assess the needs of the thousands of students who declare a disability each year. The main ‘Disability Support Form’ (DSF) is web-based and contains 17 set questions that every student is asked to complete without skip-logic paths. It is designed to support students to describe key aspects such as disabilities and request for study support (i.e., materials, tutorials, and equipment). Students have reported that they find this challenging [8], and staff also find the wider process problematic, with peak periods of demand prior to course start dates and students often missing communications or providing limited information from which to build an accurate profile.

This paper details the design of the virtual assistant (VA) and the results of two trials of it, as part of the ADMINS (Assistants for the Disclosure and Management of Information about Needs and Support) project. It extends a previous paper [19] in which preliminary results from the first beta trial were reported. It

builds upon an understanding of design issues in CUI accessibility developed by the authors [31], initial exploratory research to inform the VA design [18], and the participatory design approach followed throughout the project [32]. The beta trial aimed to identify improvements that could be made to the VA design using stakeholders' feedback (students and advisors). This also helped to identify key aspects to consider when evaluating and improving accessibility and user experience (UX) in CUI design and implementation processes. The second (main) trial was substantially larger, with 134 newly registered students who were in the actual process of disclosing disabilities as participants. The aim was to explore whether and why a CUI could be preferable to the current form-based process. This trial used a revised version of the VA that had been further developed in response to feedback provided in the beta trial. For the protocol, participants interacted with both the VA and the usual DSF in a 'counterbalanced within participants' design. Results suggest promise in the concept of using CUIs for these purposes. Feedback from the trials also identified accessibility barriers to improving the CUI design, and an understanding of benefits and preferences that can inform the further development of these systems.

BACKGROUND

The research presented here builds on two key themes: (1) the administrative challenges faced by people with accessibility needs and the opportunities of CUIs to improve access, and (2) the accessibility and UX of CUIs.

A wide variety of terminology is used to describe systems in this area, which has not been applied consistently in literature or descriptions of systems. CUI is a collective term for a variety of assistants (such as chatbots and virtual assistants) that mimic some aspects of human conversation [31]. While there are important distinctions between CUI designs, there is substantial overlap and potential for convergence between these systems. Due to their similarities, accessibility issues could be relevant across the breadth of designs.

Chatbots have a substantial history of development. They are defined as conversation systems that interact with human users via natural language [4]. Common uses include customer service, entertainment and therapy; two-thirds of all customer service operations already expected to make use of CUIs [37], and COVID-19 appears to have advanced digital transformation significantly in some areas, with firms accelerating tech infrastructure developments such as chatbots due to the pandemic [20]. Chatbots are often interacted with through text chat but spoken dialogue with these systems is also often possible.

Virtual Assistants (VAs) share the foundation of natural language and conversation with chatbots but have a more specific role to play in helping the user. VAs for general use such as Microsoft's Cortana and Apple's Siri are embedded in smartphones and within operating systems and are used to interact with these devices and with various services, such as interacting with a calendar or telling the user a weather forecast. VAs have also been designed and evaluated for more specific audiences, including to help people with cognitive impairments with their daily routine and calendar events [51]. The system in this project may be considered a VA because it assists the user in accessing the support they need, by both asking and answering user questions, and it can be addressed using speech as well as text.

The challenges of administrative processes

Completing applications, forms, assessments, and requests for information are common tasks for most people but can occur more often, and with added importance and complexity, for disabled people. The burden of these processes has been highlighted in research on disabled people's experiences of education [38], employment [26] and accessing support for independent living [10].

Reviewing literature in this area, [8] identify the following themes associated with the experiences people with accessibility needs have of these processes:

1. **Restricted pathways:** there are often limited ways to complete a process, and these may be inaccessible to some people. For example, it may be a requirement to use a telephone, attend a particular location, or engage with inaccessible digital or printed forms and documentation.
2. **Unequal outcomes:** Inequalities can arise from constraints placed on people who declare a disability which does not apply to those who do not. An example of this is described in [25] who report how websites for purchasing flights were not accessible, requiring people with accessibility needs to use the phone to make bookings, and therefore losing out on offers that were only available for web-based purchases.
3. **High effort:** Administrative processes are often time-consuming and challenging. Processes related to disabilities often entail additional steps, such as medical assessments and evidence. Assistance from others may also be required where processes are inaccessible. When a process to provide support is perceived as high effort, individuals are less likely to complete it [11].
4. **Time dependencies:** Many processes have deadlines or need to be completed by a certain time to be useful. The individual is not in control of how long these take or what delays may arise.
5. **Cause of negative emotional responses:** Processes related to disability can provoke complex and negative emotional reactions. They are often high stakes due to the importance of receiving a positive outcome, leading to anxiety. The individual may feel stigma around requesting support, and there is a dissonance in processes that seek to support equity and independence, while demanding evidence of impairment and repeated discussion of sensitive personal information.
6. **Multiplicity:** Scenarios arise where multiple processes need to be completed with time dependencies or overlapping effort. For example, students beginning their studies have to complete a wide range of processes linked to registration, course selection, accommodation and finance, alongside potentially multiple processes for disability-related support.
7. **Differing individual trajectories:** Administrative processes can be designed to assume a particular route, for example, that a student will disclose a disability before the beginning of their studies. In reality, people will meet these processes at different points, such as a change in health or recognition of an additional condition partway through their studies.

In the context of UK higher education, where this project is set, there is increasing consensus that administrative burden is a key barrier to student success [8, 9, 13]. While we cannot design a system that could fully mitigate all these issues within the scope of this project, these themes offer directions for the current and future evaluation of CUIs as a means to improve administrative processes. If CUIs can make administrative processes less challenging, more accessible, and more flexible, they will reduce the impacts completing these processes have on people and reduce the likelihood of people giving up during them or avoiding completing them altogether.

Opportunities of CUIs to improve access

Although there is limited research on the accessibility of CUIs, there are strong connections between CUIs and accessible and assistive technologies. The accessibility opportunities and barriers of CUIs present a complex space with a need for flexibility and personalisation. For example, in summarising impairments that affect speech and language production and comprehension, [42] suggest that voice-based assistants offer opportunities for speech practice but also need to support alternative input modes to avoid barriers for those with less familiar or predictable speech patterns. With some caveats, CUIs have potential to overcome the varied barriers faced by people with cognitive disabilities, for example if they can adapt to personal communication styles and reduce the need for complex interactions found in graphical user interfaces [2]. They also make recommendations which are relevant to language comprehension in CUIs, such as allowing the user to control the pace of interaction and avoiding complex sentences. [39] find positive opinions and substantial use of home voice-based assistants such as Amazon Echo, both among people with visual impairments and a wider population with various disabilities. For people with visual impairments, support to complete further and more complex tasks through voice-only interaction was desired, as well as better discoverability of commands. The use of these assistants has also been explored to support access to information for personal health management for older adults, with desire for these systems to make health data more intelligible, to support the person to verify the information about themselves which is held or interpreted by the system, and to understand subjective and social aspects of a person rather than only medical data around their health deficits [5]. From the perspective of assistive technology design, screen readers and speech-to-text assistive technologies share underlying functionality and similarities with CUIs. These connections are highlighted by [48], who note that people with visual impairments often make use of both screen readers and voice assistants, and they explore how these two currently separate tools intersect, with screen readers currently better at deeper engagement with content and VAs more convenient and accessible.

Chatbots, which are primarily but not entirely text-based, also offer opportunities and barriers. For example [29] identify how young adults with dyslexia can struggle with providing accurate spellings and complicated messages in public service chatbots. However, achievable design improvements, such as building in tolerance for spelling errors and the ability to switch from text to a voice to read out messages, might bring benefits. Chatbots have found a variety of applications in mental health including in screening and therapy, and [1] review research on user perspectives on these. The findings are largely positive but also highlight the importance of improving the linguistic understanding of these systems, as well as creating and maintaining trustworthiness. Chatbots would ideally be able to empathise and understand emotion in statements from their users, but this is a challenge for current systems.

Multimodality, and giving the user a choice of communication channels, has the potential to make the interaction more accessible [24]. CUIs can potentially use voice or text as input or output, or a mixture of these, in their conversations. More recent research on CUIs highlights the potential of voice assistants to benefit many people with physical disabilities as these systems become more mainstream and able to perform complex tasks [47].

There is also limited research to date that specifically explores how to design CUIs to be accessible. However, some reviews of the available literature have been conducted. For example, [44] developed an evaluation protocol, and related set of tests cases, which can verify if current CUIs can support the interaction of motor and visually impaired users with their mobile devices. Meanwhile, [46] surveyed existing chatbot accessibility guidance and found seventeen different sources. From this they organised recommendations for creating an accessible CUI experience into five categories: content, user interface, integration with other web content, developer process and training, and testing. Importantly, [17] highlighted that using a question-and-answer chatbot in an online course can raise wider barriers to inclusion, finding that non-native English speakers experienced significantly more barriers. Finally, [31] reviewed a range of current guidance, reports, research, and literature on accessible design for different disability groups and developed a set of questions in the further research and development of accessible CUIs.

Reviewing the wider body of literature on CUI evaluation processes, several authors have explored the potential of UX in CUIs in a range of domains such as industry [43], home devices [15], providing IT support [12] or educational experiences [33, 40, 41]. Other researchers have explored the comparison between CUIs and proposed frameworks [14, 34, 45]. These studies have commonly captured qualitative and quantitative data and used a combination of methods. Table 1 shows that many of the studies used questionnaires with task-driven or free iteration with the CUI, direct observation, or included interviews in their methodologies. However, these studies tend to omit specific considerations of accessibility aspects to be evaluated and included in the design [31].

Table 1. Methods used in CUI evaluation

	Method	Reference
1	Questionnaire	[14, 15, 40, 41, 43, 45]
2	Task driven interaction	[12, 15, 33, 40, 41, 43, 45]
3	Free interaction	[14, 34, 40, 41]
4	Direct observation	[15, 40, 41]
6	Interview	[34, 40]

Questionnaires are the most common method used in these evaluations. Several standardised scales exist to evaluate the experience of CUIs, such as AttrakDiff, Subjective Assessment of Speech System Interfaces (SASSI), the Speech User Interface Service Quality (SUISQ), the Mean Opinion Scale (MOS) and The System Usability Scale (SUS) [23]. The combination of more than one of these scales in evaluation processes is suggested [23] because they are usually designed to identify different strengths and weaknesses, therefore the combined use of several can cover broader aspects that are relevant when evaluating the design.

In this research, we have applied several of these methods to explore and enhance the evaluation of accessibility and UX in CUIs. This experience, although being challenging and with limitations, has been supportive to draw suggestions for the design of accessible CUIs.

Designing the ADMINS Virtual Assistant

The ADMINS assistant was developed using a range of Microsoft Azure Cognitive Services, including Direct Line speech for both speech recognition and speech synthesis, language understanding and knowledge base services. The VA made use of two AI Services offered by Microsoft; QnA Maker and Language Understanding (LUIS). The QnA Maker service allowed the creation of a set of possible questions (along with answers) that a user might ask whilst using the chatbot. LUIS allowed the creation of a list of intents; something a user is requiring. These were then mapped to possible utterances, the communication from the user. For both systems, AI is used to score a user's incoming communication and determine the likeliest match to a stored question (QnA Maker) or utterance (LUIS), then returning the matching answer or intent respectively. From the ADMINS chatbot, the LUIS service had two domains created; one was for intents around changing the conversation flow, such as pausing the current flow to ask a question or edit a previous answer. The other domain was more specific and was used to give possible categories of disabilities that the user may fit into from their communication of their current difficulties.

A variety of sources and methods were used to design the VA. This included analysis of the current forms and guidance, examples of completed forms, and a set of 46 recorded telephone conversations between advisors and students [18]. In addition, we followed a participatory-design approach [7], which involved both understanding students' accessibility needs and preferences, and the advisors' experiences as experts in the conversations that we intend the VA to be able to hold. Student consultants were employed to provide substantial guidance to the project. We ran two workshops with a total of 13 students and 8 advisors participating [18]. Workshop activities included the Wizard of Oz approach, which has a history of use in conversational interface design [21, 22], alongside brainstorming, visualisation, storytelling, and reflective activities to discuss aspects of the design of the VA, such as the conversation flow and persona.

The VA development flow included concept modelling, prototype design, expert-based and user evaluations [30], with feedback from the workshops and student consultants informing the conversation design [32]. The VA conversation covered the following key areas: (1) how disability might affect the university study, (2) alternative formats to study, (3) how to work with tutors, including tutorials and exam arrangements and (4) summary of the conversation. A flow diagram was used to develop the main conversation flow and explore interrupt scenarios. A conversation flow structured document was also developed to allow decoupling of the main chatbot code from the conversation detail; this was designed to allow the chatbot to be reused with different conversation flows in the future.

Figures 1 and 2 show several examples of the conversation. These scenarios present how the VA provides feedback on the user input and maintains an engaging conversation. The first scenario used in the beta trial details the disability disclosure process (case 1) and adjustment from tutor and tutorials (case 2) (see Figure 1):

Case 1:

Assistant: The OU uses the word 'disability' to cover a lot of things that you might not think of as disability, such as health conditions, autism, dyslexia, depression and anxiety. With this in mind, can you tell me a bit about any disabilities you have?

User: Sometimes I suffer with my depression. Also, my sight is not good.

Assistant: From what you have described, I've ticked these categories. Please tick or untick any categories and then press OK once you're happy (ticket Sight and Mental Health).

Case 2:

Assistant: So, what adjustments or support do you think you might need from your tutor?

User: I think I may need extra time to finish some of my assignments.

Assistant: OK, I think I've got that. The next area to look at is Tutorials. These can be either online, face-to-face groups, or day schools at various venues. Would you like me to give you any more information about OU tutorials?

User: No

Assistant: No problem. So, for online tutorials is there any adjustment or support you think you might need so you can participate? For example, your disability may mean that you do not feel able to speak but are willing to contribute by text, or you may not want to be called on directly by your tutor.

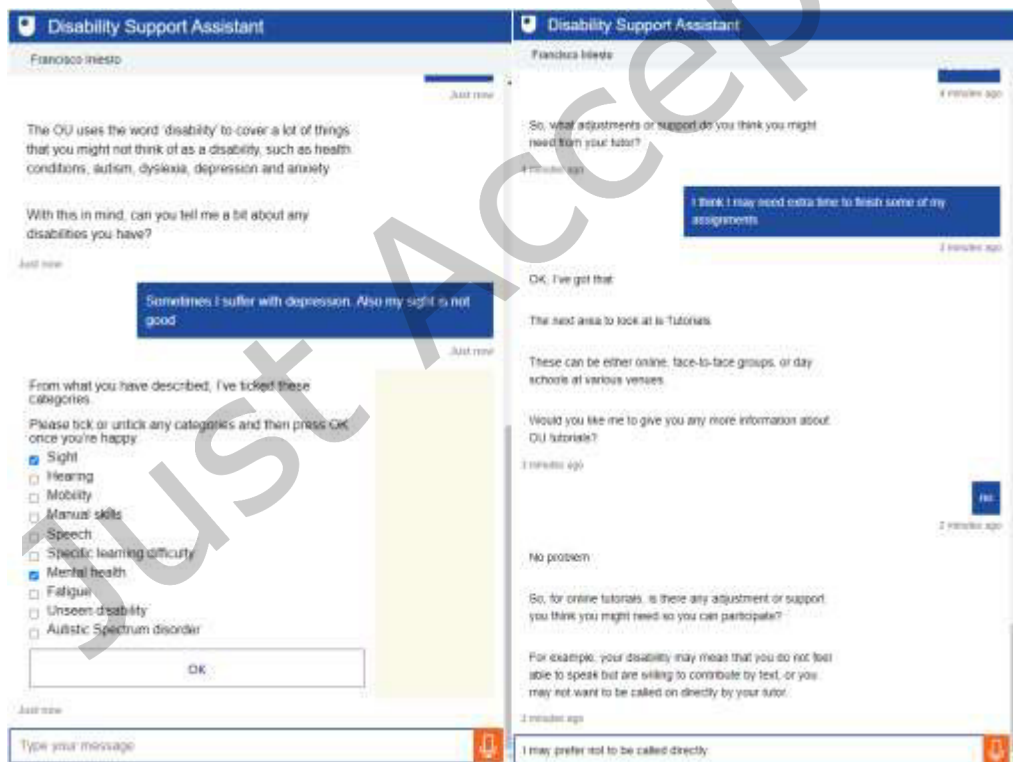


Figure 1. Scenario of the VA used in the beta trial.

From the beta trial onwards, the VA supports multiple communication modalities and alternative media options. This means students can adapt their experience when interacting with the VA to improve accessibility. Voice input and output is available alongside text to create a flexible interface to the conversations. The VA supports multiple means of communicating information [36], including explanatory videos, text, or spoken words. The second scenario represented in Figure 2 shows a question raised by the student about disclosing a disability (case 3), and the final summary presented with all the key information collected for further support from the advisory team (case 4):

Case 3:

User: Can I ask you something?

Assistant: Yes, what would you like to ask?

User: I'm not sure if I have a disability so what should I do?

Assistant: if you're not sure if your disability will affect your studies, please do tell us about it anyway. An advisor will discuss with you what support we may be able to offer, either now or in the future. If you have any other questions you can ask me now, otherwise press continue and we'll move on.

Case 4:

Assistant: Summary.

- Descriptions of your disability: I have anxiety and stammer.
- Disability categories: Mental health and speech.
- Your assistive technologies: Dragon.
- Information to pass to tutor: I'd like to be contacted by email and may need extra time for assignments.
- Face-to-face attendance: No
- Online tutorials support needs: I would rather not have to speak. Happy to use text chat.
- Discuss funding and loans: No.
- General communication needs: I prefer email and post.

Thanks for expending time chatting with me, I hope you found it useful. The conversation has now ended, you can close the chat window. Bye.

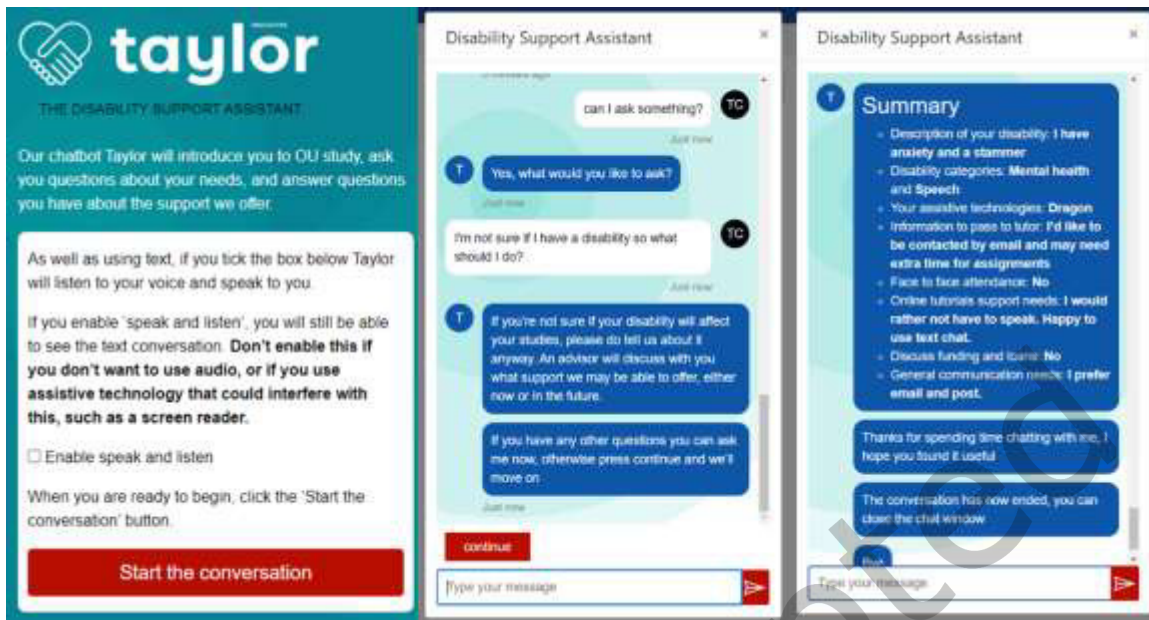


Figure 2. Scenario of the VA used in the main trial.

Following the implementation of changes proposed from the beta trial, the final main trial version included: (1) extra information through links to university or government resources, where students can expand their understanding of the terminology and find additional support outside the VA body of knowledge; (2) an extended knowledge base and responses to queries from the user (QnA Maker); (3) a customizable “look and feel” interface designed to be more usable, (4) a move away from form-based widgets embedded in the conversation to purely conversation-based approach, and (5) the ability for the user to alter the speed of the conversation flow to accommodate either a slower or faster pace.

METHODOLOGY

We aimed to address two questions regarding the design of accessible CUIs and their potential for assistance in disability disclosure and support:

- **RQ1.** What potential is there for a CUI to improve the experience of a disability disclosure process in comparison to completing a form?
- **RQ2.** What are the design requirements reported by participants when interacting with such a CUI?

RQ1 is explored through the results of the main trial, while RQ2 is answered with data provided by both the beta and the main trial. The beta trial took place in July-August 2020 and the main trial took place between November 2020 and January 2021. Both happened within the context of the COVID-19 pandemic, where using an online environment opened the opportunity for participation. In both cases, a mixed methods methodology was used, and several questionnaires were included to follow [23]’s approach of drawing on different questionnaires’ strengths.

The duration of the main trial was enough to gain a full experience with the system, with participants completing a conversation which involved equivalent questions to filling in the form. Ethical approval for the research was granted by the OU's Human Research Ethics Committee (reference: HREC/3712/Coughlan). Detailed information about the questionnaires and scales used can be found in the appendices.

Prior to each trial, the versions of the VA used were accessibility tested by expert testers from outside of the project team. For the beta trial the OU's Accessibility and Usability Team ran a full evaluation covering Web Content Accessibility Guidelines [49] level A and AA, finding violation criteria with the keyboard focus and use of screen readers. In the main trial, an external consultant was hired to produce a detailed report using assistive technologies; errors identified included the use of the focus on buttons and attributes. Additionally, there was accessibility expertise within the development team, which highlighted accessibility issues missed in development so that these could be responded to prior to the trials.

Beta Trial methods and sample

For the beta testing process, methods included free and direct observations of participants working with the VA; pre-and-post activity questionnaires; and semi-structured interviews. The questionnaire included two quantitative scales: SUS and the Speech User Interface Service Quality Reduced (SUISQ-R) - a simplified version of SUISQ. SUS has been widely used in usability evaluation at design stages [28] while SUISQ-R has been highlighted as a reliable means to evaluate CUIs UX [27].

For the observations, questionnaires and interviews, open questions about the accessibility of the system were used to allow participants to raise any accessibility barriers they noticed. Interviews were employed to seek in-depth information from the participants, reflecting on the experience of interacting with the VA and suggested improvements. To understand the individual situations in which students may be interacting with the VA and their varied accessibility needs, a Person-Centred Planning (PCP) approach was used. PCP is designed to empower people with accessibility needs to make their own choices and decisions [26]. PCP was used to allow students to choose their preferred way to interact with the VA.

A four-step protocol was used:

1. **Step 1.** Online pre-questionnaire (10 minutes)
 - a. Project sheet and consent form
 - b. Demographic information
 - c. Previous experience (open and closed-ended questions)
 - d. Access preferences when using VAs (open and closed-ended questions)
 - e. Preference for the trial (PCP)
2. **Step 2.** Online trial – Interaction with the VA (40 minutes)
 - a. Free interaction (Option A)
 - b. Direct observation with the team (Option B)
3. **Step 3.** Online follow-up questionnaire (10 minutes)
 - a. SUS (Likert 5)
 - b. SUISQ-R (Likert 7)

- c. Open-ended questions about the experience (only for option A)
- 4. **Step 4.** Online interview (Optional for selected students) (40 minutes)

A sample of students who had already declared a disability was identified by the OU’s Student Research Project Panel team. This included a split across the disability categories (with the objective of being a balanced selection for each disability category) and ensured students had agreed to be contacted for research purposes. Students were invited using a phased approach in order to balance the sample for diversity, including students declaring different disabilities and using several modalities (text\speech) and channels (device\operating system\web browser).

In total, 550 students received an email advertising the beta trial, 40 (7.2%) filled in the prequestionnaire, and a total of 22 (4%) finished the trial. Of those, 13 (60%) were female. The disabilities more frequently declared were long-term medical conditions (12, 54.5%), mental health (9, 40%), fatigue or pain conditions (8, 36.3%) and specific learning difficulties such as dyslexia (7, 31.5%). Other needs included restricted mobility (3, 13.5%), autistic spectrum conditions (3), restricted manual skills (1, 4.5%), impaired speech (1) and visual impairment (1). Therefore, although this was intended to be a small preliminary trial, the sample covered diverse needs. The participants’ ages were concentrated between 26 and 55. Most participants had prior experience of interacting with VAs, using text or combination of speech and text (Table 2).

Table 2. Previous experience in the beta trial

Age		Previous experience using VAs		Interaction with any VA	
56 and over	9% (2)	Never	9% (2)	Only speech	4.5% (1)
46-55	22.5% (5)	1-2 times	18.5% (4)	Only text	49.5% (11)
36-45	31.5% (7)	3-5 times	31.5% (7)	Speech and text	45% (10)
26-35	27% (6)	More than 5	40% (9)		
Under 25	9% (2)				

In addition to the sample of students, the same trial approach was conducted with 3 advisors from the OU’s Disability Support Team to ensure their views as key stakeholders in the system were also present. In step 2, from the total of 25 participants (students and advisors), 18 (72%) selected option A, free interaction with the VA rather than direct observation. From the sample of students who completed the trial, 5 took part in an optional post-trial in-depth interview.

Main Trial methods and sample

The main trial methodology included free interaction of participants with both the VA and DSF, pre-and-post activity questionnaires, and semi-structured interviews to seek in-depth qualitative information about the experience using both tools. For this trial, three quantitative scales were used in the follow up questionnaire. SUISQ-R was used again, providing scope for comparison with the beta trial; a Technology Acceptance Model (TAM) scale was used to measure how participants perceive that they would come to accept and use the VA in comparison to the form [35] and a further set of closed questions was developed based on [31] by the research team, to evaluate the accessibility of the VA. This was named the Conversational User Interface Accessibility Questionnaire (CUIAQ).

A counterbalanced within participants five-step protocol was used, steps 2 and 3 were equally randomised:

1. **Step 1.** Prequestionnaire (10 minutes)
 - a. Project sheet and consent form
 - b. Demographic information
2. **Step 2 or 3 (depending on randomised order).** Trial – Interaction with the VA (40 minutes)
3. **Step 2 or 3.** Trial – Interaction with the DSF
4. **Step 4.** Follow up questionnaire (15 minutes)
 - a. Comparing the DSF and the VA
 - i. TAM (Likert 7)
 - ii. Comparing the DSF and the VA (open and closed-ended questions)
 - b. Experience with the VA
 - i. SUISQ-R (Likert 7)
 - ii. CUIAQ (Likert 7)
 - iii. Feedback on the VA (open and closed-ended questions)
 - iv. Previous experience (open and closed-ended questions)
 - v. Access preferences when using ADMINS VA (open and closed-ended questions)
5. **Step 5.** Online interview (Optional for selected students) (30 minutes). PCP was used to allow students to choose their preferred way to communicate.

When starting the process of disclosing disabilities, all students were offered the chance to participate in the trial by following a banner that redirected them to Step 1. The sample was therefore not balanced, but the benefit of this approach was to increase the realism and broaden participation to new students as they disclosed disabilities. In total 306 students filled in the prequestionnaire while a total of 134 (44%) finished the trial. Of those, 97 (72%) were female. The disabilities more frequently declared were mental health (57%), specific learning disabilities (35%), unseen conditions (33, 25%), fatigue or pain conditions (22%), and restricted mobility (18%). There were fewer participants with autistic spectrum conditions (12%), restricted manual skills (11%), hearing impairment (6%), impaired speech (3%), or visual impairments (1%). The sample is a close fit (within 5%) with the university population, showing alignment in mental health (32%) and learning disabilities (14%) but less representative of the population disclosing visual impairments (3%), speech (0.8%) and hearing impairments (3%).

The ages in the sample were predominantly under 35. Students were either very experienced using VAs or never and expressed a large preference for text over speech (Table 3).

Table 3. Demographic information and experience

	Age	Previous experience using VA		Interaction with ADMINS VA	
56 and over	3.7% (5)	Never	33.6% (45)	Only speech	1.5% (2)
46-55	13.4% (18)	1-2 times	22.4% (30)	Only text	82.9% (111)
36-45	20.1% (27)	3-5 times	11.2% (15)	Speech and text	15.7% (21)
26-35	33.6% (45)	More than 5	32.8% (44)		
Under 25	29.1% (39)				

The devices mostly used by students while interacting with ADMINS VA included laptops and mobile phones (56, 41.8%, for both devices). The use of assistive technologies and preferences reported by the students while interacting included predominantly changing the contrast of colour and text size, use of subtitles and transcripts and adjusting the speech speed. 12 participants who finalised the trial took part in a semi-structured interview (4 via Skype and 8 using online questionnaires).

RESULTS

The results presented include the data of the main trial, using the final version of the VA reached during this project, and data from the beta trial in order to answer RQ2. Further results from the beta trial can be found in [19]. Attribution of quotes from participants includes the letter B – beta or M- main, plus S- student or A- advisor and a unique number.

RQ1. What potential is there for a CUI to improve the experience of a disability disclosure process in comparison to completing a form?

In Table 4, we can see the results of TAM scale for the main trial. The trial was framed as a comparison between the use of the VA as a new technology, compared to the current form-based process. The values in the four variables defined in the model are positive and above the mean (3.5). In the case of ‘**ease of use**’ (5.66), the results indicate that it is easy to learn how to use and interact with the VA (q2-6.06, q3-5.71). ‘**Usefulness**’ (5.28) is valued as positive (q6-5.71), but whether it allowed them to express their needs more easily scores the lowest within this section (q5-5.09). This theme will be explored further later in the paper. For ‘**attitude**’ (5.42) the results indicate a positive attitude towards the idea of using the VA (q7). Finally, ‘**intent to use**’ (5.32) shows that participants were generally positive about using the VA again in the future (q11-5.43).

Table 4. TAM scores (1 to 7)

Likert 1(disagreement) to 7 (agreement)		Mean	SD
Ease of Use			
1	I found the virtual assistant easier to use than the form	5.20	1.85
2	Learning how to use the virtual assistant was easy for me	6.06	1.34
3	My interaction with the virtual assistant was clear and understandable	5.71	1.61
Perceived Usefulness			
4	Using the virtual assistant enhances the disability disclosure process	5.23	1.76
5	Using the virtual assistant makes it easier to express my needs	5.09	1.91
6	I found the virtual assistant useful	5.51	1.67
Attitude			
7	I do not like the idea of using the virtual assistant instead of the form	5.13	1.92
8	I have a positive attitude toward using the virtual assistant	5.57	1.59
9	I believe it is a good idea to use the virtual assistant to disclose disabilities	5.57	1.59
Intent to use			
10	I would use the virtual assistant if it were an option rather than the form	5.32	1.88
11	I would use the virtual assistant again if my needs changed	5.43	1.79
12	I would like to use a virtual assistant like this to discuss support more often	5.31	1.74

Three further questions were used in the follow-up questionnaire of the main trial to clarify perceptions of the VA in comparison to the DSF (Table 5). Most participants report a general preference of using the VA (64.2%) over the DSF (24.6%), with small numbers having no preference (11.2%). Over half of the participants considered the VA to be more useful in developing their understanding of study and disability support (53.7%) with the rest balanced between considering the DSF more useful (23.9%) and having no preference (22.4%). In terms of information provided, preferences are similar between the VA (45.5%) and the support form (34.3%). A Chi-Square Goodness of Fit Test performed on the overall preference shows the predilection for the assistant to be statistically significant ($p < .001$). To identify if the results differed according to any of the specific disability categories students had disclosed (e.g. mental health, specific learning difficulties, mobility) or according to gender, we ran Chi-Square Tests of Independence using each

of the three questions, finding no significant relationship between the reported preference and any of these variables ($p > .05$).

Table 5. Preference of use

Key questions	VA	DSF	No Preference
Which of the two options did you prefer?	64.2% (86)	24.6% (33)	11.2% (15)
Which activity was more useful to help you understand study and disability support at the OU?	53.7% (72)	23.9% (32)	22.4% (30)
Which activity prompted you to provide better information?	45.5% (46)	34.3% (61)	20.2% (27)

Each closed question was accompanied by the option to include an open text explanation of why the answer was chosen. Further information regarding these three aspects was collected in interviews. Qualitative answers from both sources were therefore analysed following a deductive approach with three themes (and occurrences) [6]: ‘**general preference**’ (n=159), ‘**understanding gained**’ (n=70) and ‘**quality of information**’ (n=134).

Comments received under ‘**general preference**’ indicate that some participants perceived the VA to be a faster solution than the form, for example explaining their preference as “Mainly for the speed and ease of completing the information needed. The form takes longer to fill in specific information (MS45)”, and that it gives them confidence, responding “It felt more like I was discussing my problems which made it easier for me to remember and (know) what to write (MS125)”. The provision of multiple communication modalities was appreciated:

“The virtual assistant helped as with my dyslexia I like to be able to listen to information. The voice helped me to listen to what was being said but if I did not take all the information in, I could refer to the written statement/question (...). I think the virtual assistant will help many people with a range of needs as it gives the opportunity to gain information in different formats (audio, text, video etc.) and you are able to express how you feel in different formats too (MS37)”.

Participants who stated they preferred the form commented on the practice of providing examples, saying “the form provides more examples and it's easier to scroll back slightly and find the answer instead of typing out the question (MS1)”. They also appreciated having control of the speed (contrary to the position above), indicating “I was able to move through the form at my own pace, but the virtual assistant was slower than I preferred (MS69)”. Participants were critical of potential conversation breakdowns, saying “bots can only answer from a source of responses that it has, and if you have a question that veers slightly off that track, then it ends up asking you a question that is impossible to answer (MS93)”. Several of those reported preferences are accessibility barriers that could be potentially improved in the design. In that sense for some participants using the form allowed more space:

“I preferred the openness of the questions in the form more. The empty spaces on the form allowed me to fill in the information in a way that suited me. I felt that a real person would actually read the answers I wrote in the disability support form whereas with the assistant, I instinctively wrote shorter answers as I felt they would only be processed by an automated system (MS134)”.

Participants who did not indicate a preference indicated pros and cons of both solutions:

“As I am deaf, I rely heavily on online access to forms. Using the virtual assistant provides me with the same access as filling in the form online. I feel that they both have the positive aspect of providing details, but the assistant interacts more with the audience rather than the form. This means, should one have any issues, then the assistant could provide assistance, the form cannot do this (MS112)”.

In terms of ‘**understanding gained**’, participants who found the VA useful appreciated the bi-directional nature of the conversation, saying “the interaction makes it feel like you are having an actual conversation with somebody and you can clarify questions being asked instead of having to read them over and over again (MS26)”. They also found the VA to be more straightforward and time-efficient:

“The form is just a load of words on the screen, and I end up getting blurred and sometimes it's quite a long document to go through on the screen to fill out and I found the virtual system is handy because you're having a conversation as such (...). The form takes me a couple of days just to go through them all and read all I have to save and come back later, using the virtual assistant I found actually completed it within 40 minutes in one go (MS100)”.

On the other hand, the form appears to invite the input of more detailed information, and students were more likely to review and check their answers:

“All of the questions were there in front of me on the support form and as it wasn't interactive, I felt I had more time to put my answers down. I also find it easier to give full answers on the form, whereas I am more likely to give short answers using the virtual assistant (MS93)”.

Finally, for ‘**quality of information**’, some participants preferred the VA's phrasing:

“The questions were phrased better. Especially the end ones about the support options available. On the form it didn't ask any question about it, it simply showed the information about them with a drop down 'yes/no' box. The virtual assistant made it very clear what it was asking (MS24)”.

Other participants stated that the experiences were broadly comparable: “They both asked for very similar information and I feel that with both activities I was able to explain my disability and how it may affect my studies in a concise way (MS26)”.

Finally, students in the main trial were asked about areas for further development that were important for them (they could select up to three options, see Table 6). Participants indicated they would like to see more suggestions about potentially useful resources and tools, support with other forms and processes at the OU and the ability for the VA to answer a wider range of questions (something also reported in the qualitative responses.)

Table 6. Answers to the question “Which of the following areas for further development are most important”

Areas	Responses
Making suggestions of resources and tools	72.3% (97)
Helping me complete other forms and processes	47.7% (64)
Able to answer more questions	40.3% (54)
More information about Open University study	32% (43)
Better answers to questions	25.3% (34)
Videos and media	18.6% (25)
Voice input	8.2% (11)
Personality	6.7% (9)
Text input	6% (8)

RQ2. What are the design requirements reported by participants when interacting with such a CUI?

Data from both the beta and main trial gives insight into the degree to which the VA is accessible, and the types of accessibility issues that arose for participants. We report quantitative results from scales used to measure the accessibility and usability of the VA and themes raised in the qualitative data.

To compare results within trials, SUIQ-R was used in both, thus allowing comparison (Table 7). For the results we used t-tests between pairs of independent means. All questions showed a significant difference between trials except q3, q11 and q13 ($p < .05$). Some questions were answered positively, indicating that the VA was easy to use and intuitive (q6). Meanwhile, the lower score in other questions indicates inconsistencies in the VA (q14). This scale is designed to offer an overall score (4.73 - 5.45), and the positive final evaluation indicates that participants suggest the VA is better in its final version.

The scale offers a psychometric evaluation of four variables:

- **‘User goal orientation’** (UGO) and **‘Customer service behaviour’** (CSB) were 4.93-5.61 and 5.64-6.36 respectively, therefore the VA was found to support disability disclosure and offered the expected service for the OU brand. Participants indicated agreement that the VA used everyday words, was polite, courteous, friendly, and that the conversation was organised and logical, (q5, q6 and q8).
- **‘Speech characteristics’** (SC) and **‘Verbosity’** (V) had lower scores of 4.23-4.56 and 4.11-5.27. Messages were therefore repetitive; the VA was providing more details than needed (q9 and q13). However, verbosity is the variable that improves the most between the beta and main trials.

Table 7. SUISQ-R scores (Beta trial left – Main trial right)

Likert 1(disagreement) to 7 (agreement)		Beta		Main	
		Mean	SD	Mean	SD
User goal orientation (UGO)		4.93		5.61	
1	I would be likely to use the assistant again	5.28	1.40	5.43	1.79
2	I felt confident using the assistant	5.20	1.41	5.71	1.61
3	I could find what I needed without any difficulty	4.68	1.91	5.23	1.76
4	The assistant made me feel I was in control	4.56	1.78	5.23	1.34
Customer service behaviour (CSB)		5.64		6.36	
5	The assistant used everyday words	5.80	1.71	6.33	0.82
6	The assistant seemed polite	6.04	1.02	6.42	0.86
7	The assistant seemed professional in its speaking style	5.04	1.06	6.34	0.89
8	The assistant seemed friendly	5.68	1.22	6.34	0.97
Speech characteristics (SC)		4.23		4.56	
9	The assistant voice sounded like a regular person	4.12	1.62	5.19	1.44
10	The assistant voice sounded natural	4.24	1.16	5.15	1.41
11	The assistant's voice sounded enthusiastic or full energy	4.32	1.52	3.35	1.93
Verbosity (V)		4.11		5.27	
12	I felt like I had to wait to long for the system to stop talking so I could respond	4.48	1.69	5.29	1.57
13	The messages were repetitive	4.00	1.35	5.31	1.57
14	The assistant was too talkative	3.84	1.40	5.19	1.57
Overall		4.73		5.45	

The SUS questionnaire was used to evaluate the usability of the beta trial. The results of the questionnaire indicated a score of 72.3, which is classified as good (B) usability, above the average score of 68. In that trial, various issues were reported through open comments. Beta trial participants reported incidences relating to communication; the VA's comprehension ability was reported as needing improvement since the VA did not always understand the participants. This included situations in which the VA and participant could become stuck in repetitive sequences of questions, and problematic behaviours:

"This was yes/no question with no point to elaborate or another question to ask if I had proof/paperwork. Other questions would benefit with a yes/no/maybe or even just a chance to elaborate (BS18)".

Further issues included limited space to provide answers, the way questions were presented and the interaction speed:

"The reading time of the text was not proportionate to the length of each text sentence or section which caused me to have to re-read some sentences. The movement of the text rolling down the screen caused me problems to focus on the text I needed to read (BS13)".

Participants diverged in their views on the speed of speech, with some suggesting it was too slow and others that it was too fast: "The voice chat was fast, needs to be slower and messages were very quick so hard to digest (BS12)". There was also feedback highlighting points where the VA used confusing sentences or complex definitions, e.g., "The language used doesn't help for dyslexics, is too technical, for example, assistive technology, if I ask the definition, you get very long definition and uses assistive continuously, we need shorter definitions (BA3)".

From the beta trial we created a total of 163 instances of issues found in feedback for implementation. A process of grouping, prioritising, and responding to these before the main trial

was agreed by the research and development team. Based on this feedback, the team worked to improve user experience by allowing the speed of voice to be customised easily, and revising the prompts and answers provided by the VA to be more succinct. The use of form-based widgets to disclose the disabilities was eliminated.

Qualitative answers from the main trial support the identification of further design requirements. An inductive approach of thematic analysis was applied with three key themes “accessibility barriers”, “conversation experience” and “ideas for improvement”. Table 8 shows the key questions included for the analysis.

Table 8. RQ2 qualitative questions

Key questions
<ul style="list-style-type: none">• What did you like about using the virtual assistant?• What would you like to see improved in the virtual assistant?• Did you find any issues with the accessibility of the assistant?• Were there any other barriers to using the virtual assistant?
<ul style="list-style-type: none">• Varied interview questions

The themes from this analysis included: ‘**accessibility barriers**’ (n=402), ‘**conversation experience**’ (n=221) and ‘**ideas for improvement**’ (n=252). ‘**Accessibility barriers**’ identified by students in the main trial were related to problems with text to speech, e.g. “Text to speech didn't seem to work even though I selected it. Could just be my phone (MS72)” and the use of voice, e.g. “The voice randomly stopped working after one point. There was an occasion where it didn't respond to my input (MS89)”. Similar difficulties were reported by another participant:

“At one point I had to refresh the browser because pressing the send button on my keyboard was just inserting a carriage return and I could not send my message. The speech to text stopped working both times with the microphone button not being responsive (MS65)”.

Other issues included triggering involuntary actions from the VA. For example, on occasion it misinterpreted the word ‘help’ in terms of general disability support to be a request for instant help with the conversation itself. The VA also could miss out information provided by the student if they had not provided it at an expected point (e.g., as an answer to a particular question). This led to one comment where the participant noted that the VA had not recorded the information they provided properly in their summary.

The ‘**conversation experience**’ was generally positive, although some aspects could be improved, such as the use of language:

“I would personally prefer more direct language but appreciate the need for a careful balance between professional, friendly and accurate language. I personally would like to find language that is accurate, concise and professional when interacting with a virtual assistant of this type (MS S134)”.

Participants also stated a preference to be able to expand more on their answers in instances where the VA only offered closed options, such as asking for a yes or no response:

“I have hearing problems (...), the answers were a little narrow, and maybe a little more opportunity to give a little more information, maybe a text box or something. But... they squeezed you in to an answer framework that wasn't quite right (MS116)”.

‘**Ideas for improvement**’ included choosing colours and text size: “I would recommend having accessibility settings to change the font size, colour and background colour to make it easier for people to use if they need it (MS26)”. While the participant could zoom in and increase the font size using their browser settings (option tested as accessible), it could be a built-in feature. Participants also requested the ability to choose the colour combinations:

“If I could have changed the colour to a blue, black, or white background with blue letters, (...) that's what I normally do in my other programs. A function to change the background colour and highlighting of the text (MS18)”.

Some students also requested the option to search within the conversation: “to find what you said (MS82)”.

Finally, to evaluate accessibility, the designed scale CUIAQ was used in the main trial with an overall positive value of 5.61 (mean=3.5) (Table 9). CUIAQ indicated the sequence and easiness to navigate were evaluated positively (q1 and q2), that the VA showed positive but lower results in relation to assistive technologies and web browser preferences (q4 and q5), and that the VA was not particularly demanding and good at allowing time to answer (in line with the qualitative answers) (q6 and q7). Finally, the VA was seen to offer appropriate ways and options for communication, showing that offering multiple channels is useful (q9 and q10).

Table 9. CUIAQ scores

	Likert 1(disagreement) to 7 (agreement)	Mean	SD
1	The sequence of the conversation made sense	6.03	1.08
2	The conversation was easy to navigate	5.96	1.31
3	I was able to predict what the virtual assistant would do based on my input	5.17	1.34
4	The assistant was compatible with my assistive technology	4.79	1.43
5	The assistant carried forward my accessibility preferences (e.g., in my browser)	5.06	1.43
6	The assistant was not excessively demanding	5.93	1.15
7	The assistant gave me enough time to answer	6.13	1.20
8	The assistant offered well-defined options	5.53	1.58
9	The assistant offered good ways for me to communicate with it	5.72	1.49
10	The assistant offered the right options for communicating with it	5.69	1.52
	Overall	5.61	

DISCUSSION

The results described in this paper show that a CUI can be an effective alternative to a form for disclosing disabilities and describing study needs, with evidence that most participants preferred this approach. These results are particularly positive given that the VA developed within the constraints of the project

does not reach all the possibilities that can be envisaged. For example, a fuller integration with university systems, and more development time, would be needed to create a VA that could allow a student to complete multiple administrative different processes and receive ongoing support from the VA throughout their studies. However, the developed system was functional and robust enough to be used in a realistic way in the main trial, and feedback gives indications of the value that could be achieved in more advanced systems of this type. Limitations of this study include the low number of participants with visual, hearing and speech-related disabilities in the main trial. The use of questionnaires such as TAM would benefit from larger samples in the main trial. There was feedback from some participants suggesting problems related to the speech input and output features of the VA (e.g. that they could not get their microphone active or that speech output was not working). This may have negatively influenced preferences, but there was still an overall preference for the VA over the form.

The experience of a disability disclosure with CUIs

The main trial findings from the direct question about preference show a majority of participants preferred the CUI over using the existing form (64.2% vs 24.6%). There are less pronounced positive findings on two more specific areas. (1) We considered that a VA could benefit the process if it could produce better information from the conversation than would occur through a form. (2) We also identified that users could benefit by learning from the conversation in a way that might not occur with a form. For each of these there were positive results (i.e. 45.5% vs 34.3% and 53.7% vs 23.9%), but fewer participants felt that this had been achieved compared to those expressing a general preference to use the ADMINS VA.

The overall results are promising but suggest that further work beyond this proof of concept could be needed to substantially improve both the quality of information produced about the student and the learning that they get from it. Indeed, when asked what areas for further development should be prioritised, the first, third and fifth most popular responses ('making suggestions of resources and tools', being 'able to answer more questions' and 'better answers to questions') all relate to the potential for the VA to help the user to learn from the conversation. While not directly addressed in this trial, the multiplicity of administrative processes is highlighted in the responses from participants; when asked what further development they would like to see 'helping me complete other forms and processes' was the second most popular response.

In connecting the use of CUIs to administrative burden, an assumption is that a CUI can address some of the issues outlined in the literature review [10, 26, 38]. This research shows that a CUI can offer another pathway to completing processes that are accessible and flexible in the communications channel used. In this sense, it could reduce restricted pathways, such as those that would occur because a form was inaccessible or challenging for a particular group.

The positive perceptions of the VA suggest that it may be a means to counter the negative emotional responses that are found to arise from some administrative processes. Data from quantitative and qualitative responses suggests that the VA was seen as easy to use and useful, while participants showed a positive attitude using it. For some, it had the potential as a confidential way to discuss disabilities without stress. The VA could also reduce the high effort involved in processes by making these more accessible (as seen in qualitative answers the quality of the information).

Some elements are relevant to CUI design but also show the importance of the broader context of the administrative process. Unequal outcomes could emerge if differences between a CUI conversation and the form manifested as different levels of support for a student. We took steps to design the ADMINS VA such that it covered the same topics as the form and the outputs of both the VA and form were passed on for review by advisors and the next steps of the support process. As the VA is accessible, it should not cause unequal outcomes, but the overall picture of different routes through a process should be considered and monitored. That is aligned with students' preferences since, some still prefer to use a form, and with the literature, offering multiple communication modalities in line with a universal design approach [36].

Accessible and UX design requirements in CUIs

Our second aim was to analyse the accessibility and UX design issues that arose in the design and trialling of the ADMINS VA. Given that there is evidence that CUIs can raise barriers to inclusion [17] and that there remains limited literature about designing CUIs for disability-related purposes or designing accessible CUIs in general [44, 46], the feedback received and improvements made from the project trials suggest implications for improving accessibility and usability with CUIs that could apply more generally.

Firstly, the qualitative feedback suggests themes of features that the participants consider necessary or desirable. Some of these features could be delivered through other interfaces, others were not fully delivered by the proof-of-concept system used in the trials, but the data evidence that a CUI requires or is suited to delivering these features. These ways that CUIs can benefit accessibility can be summarised as:

- **Flexibility.** Use of either speech or text for either input or output, changing visual presentation and speed of the conversation.
- **Assistance.** Ability to ask questions and gain further understanding in an interactive way.
- **Focus.** Separating a complex set of questions out into a logical dialogue focused on one topic at a time.

Also, barriers identified through the feedback on both trials imply areas for attention in design, in order that CUIs are accessible and usable. Questionnaire data from both the beta and the main trial showed that barriers and issues appeared beyond those detected by expert testing and by developers with good knowledge of accessibility. We can evidence that the work of identifying issues and responding to these has enhanced the accessibility of the VA. SUISQ-R indicates a substantial improvement with regards to verbosity, having less repetitive messages and avoiding conversation breakdowns, and generally improving user confidence and its behaviour. Even though improvements between trials were introduced, participants still reported further suggestions. Barriers raised imply that the following themes need to be considered to develop more accessible CUIs:

- **The verbosity of messages.** Leading to a lot of information to interpret and a less interactive dialogue.
- **Misunderstanding the system and related processes.** That it would automatically interpret all answers rather than providing these to staff to interpret as well, that it would only work with short responses or required responses to be made quickly.

- **Robustness of speech input features.** Such that they work consistently well across diverse users and types of devices.
- **Breakdowns or narrowness of expected responses.** For example, misunderstanding the user's intent or not providing them enough scope to express themselves.

CUIs need to provide clear user expectations of the actions that are possible to achieve through its use [34, 43]. Therefore, the role of a CUI needs to be clear, what the CUI interprets needs to be presented back to the users at appropriate points in the conversation. This is an aspect that helps mitigate the risk that unexpected outcomes emerge from the system misinterpreting user statements. As it has been shown from the feedback, users may require extra time and the speed needs to be adaptable and work with assistive technologies. Design efforts to improve timing and interpretation could also reduce the potential for anxiety in completing what are often very important processes for the user.

Although statistical analysis did not suggest that participants reporting any particular type of disability had significantly different preferences for the assistant or form, some of the qualitative feedback does suggest ways in which particular disabilities or functional needs relate to these features and barriers. For example, participants with dyslexia found it valuable to have the assistant speak information to them, alongside presenting this information in text messages as well. Others with cognitive disabilities can benefit from a conversational approach that breaks down the range of information the university wants to know into topics dealt with one at a time.

Much of the research in this area to date has focused on how CUIs can benefit or present barriers for those with a particular type of disability [40, 48], however, systems with an administrative and support function like the ADMINS assistant need to serve all students in an accessible and equitable way, so it is important to conduct research with a broad inclusive remit. This brings tensions into play; for example, there is no single speed for the conversation that suits all potential users, at the same time these users may not be aware that they can change the speed of the conversation, and while the system can communicate this to them, there is also a desire to reduce the number and verbosity of messages coming from the assistant. Tensions like this highlight a need to explore designs for personalisation and flexibility in CUIs to combine maximum accessibility with a good user experience.

CONCLUSIONS

This paper reports results from two trials. The beta trial using an early version of the VA provided understanding of accessibility challenges and issues in user experience. After improvements to the design, a larger main trial was conducted with 134 students who disclosed their disabilities to the university using both the VA and the existing form-based process. The results show that the VA was preferred by most participants to completing the form (64.2% compared to 24.6%). Qualitative and quantitative feedback from the trials also identified accessibility and user experience barriers for improving CUI design, and an understanding of benefits and preferences that can inform further development of accessible CUIs for this design space.

Other sources of data, such as conversation logs from students, will form part of future analyses to understand interactions at a more detailed level. Pre- and post-trial comparison questionnaires in future

iterations could be helpful to understand whether attitudes towards the system, or the potential of virtual assistants for these purposes, had changed or not. It is also important to dig deeper into the accessibility features and barriers apparent for users with different disabilities, devices and assistive technologies. There are many choices to make in conversation design, language use, and ability to personalise or control the conversation, which raise questions for how best to design accessible CUIs.

Through these findings, we illustrate the potential of a VA in the domain of disability disclosure and support in an educational context and can suggest that there is value to investigating this and other CUI approaches in related domains. While we have focused on designing and trialling a system in one institution, we are exploring similarities and differences with the disability support processes in other institutions, to understand how the approach developed in ADMINS could be adapted and used more widely. Furthermore, there is potential for assistants that tackle burdens and challenges in the broader administrative processes that people declaring disabilities often experience.

This work also emphasises the human aspects of designing AI-based systems and their place in wider processes that impact on our daily lives. The design process has also benefited from rich engagement with these staff and students to understand the qualitative aspects that make a successful CUI design and the barriers to accessibility that need attention. The VA is not a replacement for conversation with human disability advisors but is instead conceived of as a means to enable them and students to understand needs and complete processes in more effective and human-friendly ways.

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APPENDICES

Detailed information for the Beta trial

1. **Step 1. Online pre-questionnaire**
Previous experience using VAs
 1. How many times have you used a virtual assistant before? (Never \ 1-2 times \ 3-5 times \ More than 5 times)**Preference for the trial (PCP)**
 2. At the end of step 1, you will be presented with the following options to complete as step 2, please choose one: (Option A. Interact with one of our researchers while working with ADMINS. Then you will answer a short online questionnaire on your own \ Option B. Interact with ADMINS on your own following a set of instructions. Then you will answer a detailed online questionnaire)
2. **Step 2. Online trial – Interaction with the VA**
Free interaction (Option A). Instructions given to students:

Thanks again for participating in this trial. You will now interact with our ADMINS virtual assistant, which can be accessed here: URL.

Please try to use both text and voice options while interacting with ADMINS. While interacting with ADMINS you will be guided to provide answers about questions regarding disability disclosure, use of assistive technologies, alternative formats you may like to use in your module material and your preferences about tutors, tutorials, and communication preferences.

It may be useful for you to take notes about your experience while interacting with ADMINS to answer the follow-up questions. If you reach a barrier that stops you from completing the evaluation, please do inform us, and we will find an alternative solution. Once you have finished working with ADMINS, please fill in the follow-up questionnaire available here: URL.

Do not hesitate to contact us for any question and let us know when the questionnaire has been submitted.

Direct observation with the team (Option B). Instructions given to students:

Many thanks for agreeing on participating in the ADMINS trial.

You will now interact with our virtual assistant with our team. Please let us know your availability during this week, to find a time that fits you well. We want to use Skype for the interaction since that will allow us to share your screen and record it. Please confirm if that software is OK, and if so, your username. Otherwise, we can think of an alternative. While interacting with ADMINS, you will be guided to provide answers about questions regarding disability disclosure, use of assistive technologies, alternative formats you may like to use in your module material and your preferences about tutors, tutorials, and communication preferences. Once we have finished working together with ADMINS, we will send you a short follow-up questionnaire.

Do not hesitate to contact us with any question.

3. **Step 3. Online follow-up questionnaire**

SUS Likert 1-5 (Strongly disagree / Disagree / Neutral / Agree / Strongly agree)

1. I think that I would like to use the assistant frequently.
2. I found the assistant unnecessarily complex.
3. I thought the assistant was easy to use.
4. I think that I would need the support of a technical person to be able to use the assistant.
5. I found the various functions in the assistant were well integrated.
6. I thought there was too much inconsistency in the assistant.
7. I would imagine that most people would learn to use the assistant very quickly.
8. I found the assistant very cumbersome to use.
9. I felt very confident using the assistant.
10. I needed to learn a lot of things before I could get going with the assistant

SUISQ-R Likert 1-7 (Strongly disagree / Somewhat disagree/ Disagree / Neutral / Agree / Somewhat agree/ Strongly agree)

- User goal orientation
1. I would be likely to use the assistant again
 2. I felt confident using the assistant
 3. I could find what I needed without any difficulty
 4. The assistant made me feel I was in control
- Customer service behaviour
5. The assistant used everyday words
 6. The assistant seemed polite
 7. The assistant seemed professional in its conversation style
 8. The assistant seemed friendly
- Speech characteristics
9. The assistant voice was pleasant
 10. The assistant voice was easy to understand
 11. The assistant's tone of voice was appropriate
- Verbosity
12. I felt like I had to wait too long for the system to stop talking so I could respond
 13. The messages were repetitive
 14. The assistant was too talkative

Open-ended questions about the experience (only for option B)

1. Tell us what device(s), operating system (OS)(s) and browser(s) you have used to interact with the assistant
2. How would you describe your overall experience of using the ADMINS assistant?
3. Was there any barrier that stopped you from completing the conversation? If so, please let us know (please say which device\OS\browser this applies to)

4. How did you find the process of disclosing disabilities and assistive technologies?
 5. Do you have any comments on the questions regarding Open University study such as alternative formats, tutors and tutorials?
 6. How could the assistant be improved?
 7. Did you feel the information provided was enough and clear? How could it be improved?
 8. After you complete the conversation with the assistant, you get a summary of the key information you have provided. Do you have any comments on this summary?
 9. Was the language clear and easy to understand? Were there any instances where this could be improved?
 10. What was your impression of the voice used by the assistant in the speech version?
 11. How did you find the interface of the assistant?
4. **Step 4.** Online interview (Optional for selected students).
To expand the experience and improvements from the precious step.

Detailed information for the Main trial

1. **Step 1.** Prequestionnaire
2. **Step 2 or 3 (depending on randomised order).** Trial – Interaction with the VA
3. **Step 2 or 3.** Trial – Interaction with the DSF

Thank you for agreeing to participate in this trial. The project is evaluating a virtual assistant as a means of disclosing and understanding disability related support at the Open University.

The virtual assistant can interpret speech or text input and respond via voice or text. When you use it you will be asked questions and also be able to ask questions. Your answers are used to create a summary to use in a follow up conversation and to create a personal profile.

The purpose of the trial is to compare your experience of using the Disability Support Form (DSF) and the virtual assistant, for that reason you are going to interact with the virtual assistant and complete the form. After this you will be asked to answer a survey to get your feedback. Please provide accurate information in both the form and the conversation with the assistant.

You will need to log in with your Open University credentials to access both the DSF and the visual assistant. Please allow about an hour to complete the process, although the time required will depend on how you answer the questions. You can take your time to complete each step and do not need to do them all at once. You should try to complete the tasks as soon as you can. Please let us know if you are unable to do so.

1. Please use the link below to access the virtual assistant, and complete a conversation: URL
 2. Once you have completed the conversation with the assistant, use the following link to complete the Disability Support Form: URL
 3. Once you have submitted the form, please answer the following questions in this questionnaire: URL
4. **Step 4.** Follow up questionnaire (15 minutes)
Comparing the DSF and the VA
TAM Likert scale 1-7 (Strongly disagree / Somewhat disagree/ Disagree / Neutral / Agree / Somewhat agree/ Strongly agree)
Ease of Use
1. I found the virtual assistant easier to use than the form
 2. Learning how to use the virtual assistant was easy for me
 3. My interaction with the virtual assistant was clear and understandable

Perceived Usefulness

4. Using the virtual assistant enhances the disability disclosure process
 5. Using the virtual assistant makes it easier to express my needs
 6. I found the virtual assistant useful
- #### Attitude
7. I do not like the idea of using the virtual assistant instead of the form
 8. I have a positive attitude toward using the virtual assistant
 9. I believe it is a good idea to use the virtual assistant to disclose disabilities
- #### Intent to use
10. I would use the virtual assistant if it were an option rather than the form
 11. I would use the virtual assistant again if my needs changed (UGO -1)
 12. I would like to use a virtual assistant like this to discuss support more often

Comparing the DSF and the VA

1. Overall, which of the two options did you prefer? (DSF / assistant / no preference)
2. Why?
3. Which activity was more useful to help you understand disability support at The Open University? (DSF / assistant / no difference)
4. Why?
5. Which activity prompted you to provide better information? (DSF / assistant / no difference)
6. Why?

Experience with the VA

SUISQ-R

Same questions than in the beta trial

CUIAQ Likert 1-7 (Strongly disagree / Somewhat disagree/ Disagree / Neutral / Agree / Somewhat agree/ Strongly agree)

1. The sequence of the conversation made sense
2. The conversation was easy to navigate
3. I was able to predict what the virtual assistant would do based on my input
4. The assistant was compatible with my assistive technology
5. The assistant carried forward my accessibility preferences (e.g. in my browser)
6. The assistant was not excessively demanding
7. The assistant gave me enough time to answer
8. The assistant offered well-defined options
9. The assistant offered good ways for me to communicate with it
10. The assistant offered the right options for communicating with it

Feedback on the VA (open and closed-ended questions)

1. What did you like about using the virtual assistant?
2. What would you like to see improved in the virtual assistant?
3. Which of the following areas for further development are most important (pick up to three) (Making suggestions of resources and tools that could help me \ Videos and media \ More information about Open University study \ Better answers to questions \ Able to answer more questions\ Helping me complete other forms and processes \ Voice input \ Text input \ Personality \ Other (leads to open text))
4. Did you find any issues with the accessibility of the assistant?
5. Were there any other barriers to using the virtual assistant?
6. Do you have any other comments?

Previous experience using VAs

Same questions than in the beta trial.

Access preferences when using ADMIN'S VA

1. How did you decide to communicate with the virtual assistant? (Text \ Speech \ Both)
2. Please explain why you chose to use this way to communicate with the virtual assistant.
3. Which devices did you use when interacting with the virtual assistant? (Used my mobile phone\ used my laptop\ used my desktop computer \ used my tabled \ Other (leads to open text))
4. Which operating systems did you use for the trial? (Microsoft Windows \ Apple macOS \ Linux \ Android \ Apple's iOS \ Other (leads to open text))

5. Which browser did you use during the trial? (Google Chrome \ Apple Safari \ Firefox \ Internet \ Explorer & Edge \ Other (leads to open text))
 6. Did you use any assistive technologies during the trial? (for example, a screen reader, magnifier, or specialised input device). If yes, please describe what you use.
 7. Did you use any accessibility features or browser options during the trial? (For example subtitles, transcripts, changing the size of text, changing contrast or colour) If yes, please describe what you used.
5. **Step 5.** Online interview (Optional for selected students).
- Experience**
1. Regarding the experience of interacting with Taylor. How would you improve it? What would you like to change and see in a future version of the virtual assistant?
- Language and voice**
2. Considering the written language used. Were there any instances where this could be improved? What kind of language would you like to find when interacting with a virtual assistant of this type?
- Conversation**
3. How did you feel about the prompts and requests for information that the assistant made? Were they very straight forward or comprehensible?
 4. Did the sequence of the conversation make sense? How would you improve it to make you feel comfortable?
 5. Were the outcomes of your actions as you expected? When interacting with the virtual assistant, was there anything unexpected or surprising?
 6. Were there any points where the conversation broke down? (e.g. because of a misunderstanding) if so, what was this like and how was it recovered?
 7. Did you feel able to navigate the conversation (e.g. checking back on what was said, or asking to change something)? If not, how would you improve that?
- Interface**
8. How did you find the appearance of Taylor? What did you like, and what would you improve?
 9. What about the colours used and fonts? Would you change anything?
 10. Would you like to add anything to its personality? (anything visual to improve its look and feel)
- Summary**
11. How would you improve the summary offered at the end of the conversation? Was there anything missing there?
- Relationship with the Disability Support Form**
12. How do you think interacting with the virtual assistant is different than completing the disability support form?
 13. Were there any questions or aspect in the disability support form that you liked more than in Taylor? If so, what were those?
 14. The other way around, were there any aspect in Tylor that you liked more than the disability support form? If so, what were those?
- General**
15. In general, which aspects do you think you would like to see in a virtual assistant like Taylor and that you missed?
 16. What features would like to see that would make a virtual assistant like this helpful when completing administrative processes?
 17. Are there other forms or processes that you have to complete where you think a virtual assistant could be helpful? If so, why?
 18. How has the whole process of registration and disability declaration at the Open University been for you so far? Do you think that the assistant could have been introduced in a different way? (e.g. earlier in the registration process)