Supporting older adults in using technology for lifelong learning: the methodological and conceptual value of Wizard of Oz simulations

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Abstract

In the past, many technological initiatives have failed to engage adult learners in any significant way in part due to the lack of technological initiatives that build on people's existing interests but also because of an insufficient focus on designing co-operative technologies that can be used effortlessly. In this paper we provide our experiences of the use of Wizard of Oz (WOz) studies in order to develop a technological tool to support older adults' use of the Internet for learning, where we aimed to achieve a more learner centred approach to design. Wizard of Oz simulation is a research method common in Human-Computer Interface (HCI), Natural Language Processing (NLP) and other human factors/computer usability research where researchers conceal themselves from research participants and use communications technology to pretend that a prototype or incomplete computer-based conversational system is fully functioning. The purpose of a WOz simulation is usually to investigate and inform the development of a technology that has yet to be developed, or to learn more about how people interact with the system in order to improve the design. In this paper we outline the understandings we developed using this technique, highlighting the methodological and conceptual value of using this approach. Based on conducting Wizard of Oz simulations with 20 older adults with a diverse range of educational backgrounds and technological expertise we ask: what are the methodological benefits and challenges of using Wizard of Oz simulations in studies of learning and the Internet? In this paper, we argue that the use of Wizard of Oz approach could be a valuable method to employ for a wider range of research that examines networked learning in formal or informal settings. This is particularly the case as one (unanticipated) effect of the study was how the use of this technique developed our understandings of the everyday experiences older adults have with computers and the Internet when trying to learn new things. In addition we argue that the use of this method is important in the current context where a common criticism of technologies that are designed to support learning tend not to be fit for purpose, as they have either been developed initially for commercial uses or developed without a strong understanding of the learner in mind.

Keywords

Wizard of Oz Simulations, adult learning, lifelong learning, online methods

Introduction

The importance of enabling older adults to engage in a wide range of learning opportunities is well recognised – to support them in work, to combat social exclusion and to reduce age-related declines in cognition (Feinstein et al. 2003). The use of new technologies may be one way to support such learning activities. However, often technological initiatives have failed to engage adult learners in any significant way in part due to the lack of technological initiatives that build on people's existing interests (Selwyn et al. 2006); and an insufficient focus on designing co-operative technologies that can be used effortlessly. Given this context, we wanted to try and

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develop a technological tool – the Learning Companion (LC) - that would help older adults to learn new things in their own time, and on their own terms.

The Learning Companion (LC) – is designed to help adults make more productive use of the Internet for their personal self-directed learning, and to help them to develop their ICT skills at the same time. At the outset of the study we conceptualized the Companion as an embodied conversational agent on the computer screen which stays with the user over a period of time, gets to 'know' the learner and interacts with them, using natural language processing. The interactions the learner has with the companion are intended to help the user to take increasing control over their learning; by providing encouragement, appropriate questioning, building upon

persistent knowledge of on-going explorations and discoveries (see Eynon & Davies 2010).

As part of the first stage development of the Learning Companion we wanted to know more about what the particular needs of older adults were for using computers and the Internet for learning, the acceptability of the tool for the target group, and how they would talk and react to the Companion. We decided to use Wizard of Oz studies for these purposes, partly as they are a common technique in research that involves natural language processing, and useful in studies such as this which look to shape what technology could do in the future as opposed to what is achievable immediately, but also because we believed the method could provide us with a number of benefits at early stage of the study, supporting a more learner centred approach to design (Soloway, et al., 1994); and producing greater insight into how older adults learn using the Internet.

In this paper we outline some of the experiences we had in using this methodological approach and argue that it is a technique that may have value in a broader set of contexts and approaches to networked learning. This is perhaps particularly important in the current context where a common criticism of technologies that are designed to support learning tend not to be fit for purpose, as they have either been developed initially for commercial uses or developed without a strong understanding of the learner in mind (DfES, 2009).

Wizard of Oz

Wizard of Oz (WOz) simulation is a research method common in Human-Computer Interface (HCI), Natural Language Processing (NLP) and other human factors/computer usability research (cf. Bernsen et al. 1993; Dahlback et al. 1993; Hajdinjak & Mihelic 2003). The method, first described by Gould and colleagues in their proposed development of a 'simulated listening typewriter' (1983), was named after the character from the Judy Garland film (1939; based on the novel by L. Frank Baum, 1900) by Jeff Kelley (1983). Just as the Wizard of Oz hides behind a curtain and uses amplified ventriloquism to masquerade as 'Oz, the Great and Terrible', in WOz simulations researchers conceal themselves from research participants and use communications technology to pretend that a prototype or incomplete computer-based conversational system is fully functioning: "the experimenter, acting as the 'Wizard' surreptitiously intercepts communications between participant and program, supplying answers and new inputs as needed" (Kelley 1983, p.1).

The purpose of a WOz study is usually to investigate and inform the development of a technology that has yet to be developed, perhaps because that technology is beyond current capabilities or because to do so would be prohibitively costly or time-consuming. It is an attempt to address the designer's dilemma: how to know how something will be used and experienced, to identify usability issues and opportunities so that its design might be optimised, before that thing actually exists: "the designer is caught in a vicious circle – it is necessary to know the characteristics of dialogues between people and automata in order to be able to build the system, but it is impossible to know what such dialogues would be like until such a system has been built" (Fraser & Gilbert 1991, p.81).

In a WOz study, where human-computer communication is the focus, the researcher takes on the role of the computer, becomes the 'wizard', and mediates the 'conversation' between participant and the prototype technology. The wizard interprets the verbal contributions of the participant and responds in such a way as to convince the participant that they are communicating with a computer that understands what they are saying. As a result, the participant experiences the technology close to how it is envisaged, giving the study a high degree of realism and allowing the researcher to infer from their observations of the participant's interactions with the simulated technology how they might interact with the fully realised technology. This in turn allows progressive refinement of the simulated technology, thus avoiding design cul-de-sacs, based on the researchers' experience and feedback from participants which informs how the full technology might most effectively be designed (Dow et al. 2005).

As with all research methods, WOz simulation may be operationalised in a number of ways and various components and dimensions can be identified. These include:

- Prototype functionality: how closely the prototype technology approximates the fully functioning envisaged technology.
- WOz technology functionality: for example, whether the researcher/wizard (henceforward, wizard) communicates by means of typing or by choosing predefined sentences from menus.
- Wizard visibility: whether the wizard is seen or unseen, and heard or unheard.
- Wizard experience: the experienced gained by the wizard using the WOz technology in other WOz sessions with real participants.
- Wizard knowledge: the familiarity of the wizard with the technology being studied and, if applicable, the domain.
- Wizard control: whether the wizard provides all of the functionality or the WOz system provides some automatic responses.
- Wizard discretion: whether the wizard is constrained by a set of pre-configured options or is free to determine their actions within the simulation.
- Wizard task: what the wizard aims to achieve through the conversation.
- The number of wizards: additional researchers sometimes provide support to the lead wizard or take turns to play the wizard role.
- User knowledge: the extent to which participants are aware of the wizard's role.
- User understanding: the extent to which the user understands the true nature of the study, the risks, deception and consequences.
- Research design: from tightly controlled experiments to free exploration (cf. Höysniemi & Read 2005).

The study

As noted above, the purpose of the project was to explore the feasibility of a computer based conversational agent - the Learning Companion (LC) – to support adults in making productive use of the Internet for learning. The concept and technological input for this study draws on some of the work carried out by Wilks and others for the Companions Project, EU-funded research that aimed to develop a virtual conversational companion able to communicate with users primarily through speech (Wilks 2008; Wilks 2009). As the first step to creating a fully functioning Learning Companion we conducted the current study.

The study involved ten female and ten male participants, whose average age was 73 (range from 59 – 81). All but three of the participants were retired from work, and all of them were involved in a range of leisure activities (from rambling to local politics). There was a wide range of computer and Internet experience among the participants. Whilst two of them had never used a computer, most of them had been using computers and the Internet several times a week over three or four years. Nevertheless, only a third of the participants thought of themselves as confident computer or Internet users, and most of them mentioned that they value help from others when they are using the Internet to find out about things.

For the current study, the WOz setup comprised two computers, one operated by the researchers (the wizard's computer), the other for the use of the participants. The computers were situated in rooms some distance from one another, so that the participants were unaware of the existence of the wizard, to help maintain the WOz illusion, and were connected via the Internet. On the wizard's computer, there were three tools: a window showing what was being displayed on the participants' computer; an audio feed from the participants' computer; and a text entry box (Bradley et al. 2009). The participant's computer screen showed an avatar (or, more properly, an embodied agent, Bailenson et al. 2008), in the form of an anthropomorphized cartoon computer, an Internet web browser, and a text display window. The cartoon computer was chosen as the most neutral of the characters available in the WOz software in order to minimise the so-called 'uncanny valley' effect, the sense of strangeness we experience when we encounter things that are very humanlike but not human (Mori 1970). A microphone in the participants' room enabled the wizard to hear what the participant was saying.

On arrival at the research venue, the participants were asked to complete a short questionnaire, detailing their experiences of using computers and the Internet for work, pleasure or learning. They were then briefed about the purpose of the Learning Companions research and what they were being asked to do. They were told that the research was investigating prototype computer software that converses in real speech about using the computer and Internet for learning. The computer would ask them questions and they should reply as they felt appropriate. The aim was for this to develop into a short initial conversation – which in the proposed software, but not in this prototype, might become an ongoing occasional conversation developing over several months, to help them with a formal or informal learning project of their choice. The participants were also informed that they could stop this initial conversation at any time and that, as this was a prototype technology, there might be some human involvement in the computer's contribution.

The sessions, the conversations between wizard and participant, lasted for 15-20 minutes, and focused on the participant's interests – particularly those interests that they might like to learn more about. The wizard's task was to guide the participant towards identifying an interest that might be developed into a future learning project involving the use of the Internet. Within that remit, the wizard was free to develop the conversation, to build upon the participant's inputs, in any way they thought might be effective. The wizard asked questions or responded to the participant by typing into the text entry box. On the press of the enter key, what had been typed on the wizard's computer was 'spoken' by speech synthesizing software on the participants' computer. Simultaneously, the text also appeared in the text display window on the participants' computer, as a running log of the cartoon computer's part of the conversation. Figure 1 shows the layout of the participants' computer screen.

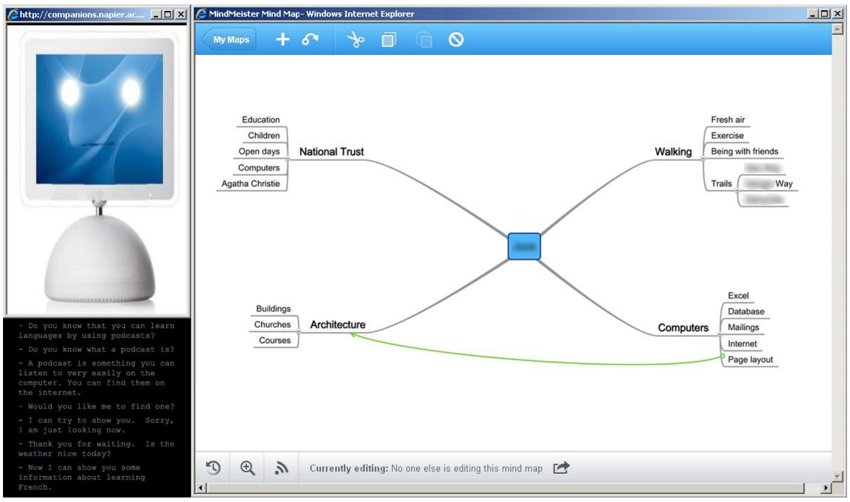

Figure 1: the Learning Companion Interface

The method used by the wizard to facilitate text entry for their part of the conversation developed over the course of the research, as the wizard gained experience and confidence in using the system. Initially, a brief script was written, containing a number of questions with which to begin the conversation. At the start of the research, this script functioned mainly as a visual cue and the text was most often adjusted before being typed into the text entry box. As the script developed, in light of each conversation and the participant's feedback, it became possible to refine the questions for copying and pasting from the script directly into the text entry box. This made the process both easier and faster, and reduced the possibility of typographical errors which would compromise the voice synthesis and might spoil the WOz illusion. However, copying and pasting pre-written questions was only possible at the beginning of the conversation and at key turning points, such as when the wizard changed the direction of the conversation or when the conversation was being concluded. At other times, when the conversation was free-flowing or when the wizard was responding to the participant and the wizard's dialogue turns could not be predicted in advance, the text had to be typed directly into the text entry box before being carefully checked and sent to the speech synthesiser.

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Because of the heavy cognitive load on the researcher playing the role of the wizard, a second researcher was also present. While the first researcher concentrated on engaging the participant in a developing conversation, the second researcher provided support: researching online the various topics about which the participants indicated they might be interested in learning, to provide the first researcher with information to feed back into the conversation, and recording key aspects of the information provided by the participants. During this qualitative study we used a number of different ways to record this conversation in order to present back to the user including using Evernote. However, in the end we found using mind-mapping software for participants a particularly valuable way of achieving this goal. The resulting mind-maps, which were intended to represent a provisional starting point for a developing learning project, were made visible to the participants in the web browser on their computer screen and were also retained for analysis. Other data recorded included all of the audio (both the wizard's and the participant's speech), the running text log of the wizard's speech and, by means of screen-capture software, everything displayed on the participants' computer screen.

At the end of the sessions, in a post-hoc debriefing, the participants were interviewed about their experience conversing with a computer: whether they enjoyed the experience, what they thought of the talking cartoon character, what their reaction was to speaking with a computer, whether they found the system helpful, whether they thought that such a system might help them with a future learning project, how they thought the system might be improved, and so on. Finally, they were told about the level of human involvement in the control of the system, the existence of the wizard. Table 1 provides an overview of the Wizard approach utilised in this study.

Table 1: Summary of the Learning Companion Wizard of Oz study

TAXONOMY	LEARNING COMPANION
Prototype functionality	The prototype comprised a bricolage of pre-existing technologies, entirely driven by the wizard.
WOz technology functionality	Sentences typed by the wizard were converted into speech, which were spoken by an embodied agent (a cartoon talking computer). Audio feed from participant to wizard.
Wizard visibility	The wizard was unseen and unheard, by being in another room some distant away from the participant's room.
Wizard experience	After some practice with research associates acting as participants, the wizard gained experience through the study.
Wizard knowledge	The 'Learning Companion' project is deliberately non-domain specific. Information fed into the conversation was derived from the Internet.
Wizard control	The wizard provided all of the functionality.
Wizard discretion	Within the confines of the task, the wizard was free to determine their contributions to the conversation.
Wizard task	The wizard's aim was to guide the participant towards identifying an interest that might be developed into a future informal learning project involving the use of the Internet
The number of wizards	A second researcher provided support for the wizard.
User knowledge	The users were unaware of the wizard's role, but were informed that as this was a new technology there might be some human intervention. The amount of intervention was not specified.
User understanding	The user was informed of the general aim of the study, but was not aware of the WOz elements.
Research design	The study was a speculative exploration of the issues.

Findings

Similar to other research, we found the use of WOz simulation very valuable as the method makes it possible to research a future technology that does not now or might never exist, enabling very early speculative enquiry, based on what we would like the technology to do, rather than what it already does. This enables a certain "freeing up" of thinking which focuses on the interaction between the learner, educator and technology where technology does not lead the agenda. Indeed, a number of researchers and policy makers have stressed the need for educational experts to have a stronger say in the designs of technology for learning (DfES, 2009). Wizard of Oz is perhaps one, relatively inexpensive way of exploring future possibilities and joining in the debate (c.f. Bernsen et al. 1993). Indeed, like others we also found it a highly flexible method; as we could experiment with different approaches to engaging the participant in conversation more easily and quickly than would be the case with a fully-functioning technology, allowing a variety of iterations to be evaluated and improved upon.

For the research team, the WOz method also allowed insights into how the participants might use a Learning Companion to support their learning using the Internet and, after a few sessions, the ways in which a conversation might develop and how the tool could support learning. Indeed, a key aspect of the purpose of using this technique was for us to investigate how real people experience conversations with computers: how they adjust their mode of speaking, syntax and intonation; what problems, if any, they experience; which aspects of the technology is of most significance to them; what their expectations are, and in what ways those expectations are addressed; how they negotiate the conversation, in what ways they are willing or unwilling to compromise; and so on. All of this is likely to be quite different from their experiences of ordinary human-human conversations: "human-human and human-computer dialogues differ in such an important way that the data from human interaction becomes an unreliable source of information for some important aspects (in particular the style and complexity of interaction) of designing natural language dialogue systems" (Hajdinjak & Mihelic 2003, p.1). And as technology featuring human/computer conversation becomes more common, understanding how real people experience conversations with computers is likely to be of increasing interest to social scientists.

An important aspect of this study was that through the use of WOz simulations and follow up interviews we obtained a very valuable picture of how older adults felt when trying to use computers and the Internet. For example, the level of frustration in the "geeky" nature of computers; the feeling of being overwhelmed by all the information available; the knowledge that the computer and the Internet could offer them "more" but not knowing the language or how to expand their knowledge to find out what that was precisely; the dislike of playing, experimenting and needing to re-remember how to do things; but also the joy and sometimes pride in being able to achieve certain things and the excitement of what the Internet (at times) offered them for learning and finding out about new things. We believe that this kind of data (c.f. Eynon et al., forthcoming) is different to that which can be obtained through other more traditional social science methods such as observation, interviews and surveys. Some of these understandings were reached when talking to the computer, others in the interview after the simulation, but we suggest it is not until you offer people a different way of interacting with technology that these kinds of issues can become clear.

While the benefits of using the technique significantly outweighed the negative for our study we did encounter some challenges. Some of these were due to the technology being used, others due to the method itself. Technological problems were relatively unsurprising, due to usability issues and occasional connectivity problems that we will not dwell on here. More interesting, was that the method presented a number of challenges that were quite different to those of other more established Social Science techniques. An important issue was the unexpectedly high cognitive load experienced by the wizard (c.f. Dow et al. 2005; Read et al. 2005). This is caused by a number of factors. First, the human researcher has to act like a computer that is trying to act like a human, a psychological conundrum that can be difficult to negotiate and maintain. Second, the wizard is being called on to simulate a technology that does not yet exist and has yet to be fully thought-through, which means that they are constantly having to make judgements about what the technology might reasonably be able to do if it was actually realised (Bernsen et al. 1993). Third, the Wizard has to guide the conversation so as to meet the specific demands of the study; and be timely, consistent and accurate in order to maintain the deception (Turing 1950). Inevitably, achieving all of this can be difficult, which is why the literature frequently emphasises that wizards need extensive training and practice before they will be able to maintain a convincing performance (cf. Salber & Coutaz 1993).

In our study we found that a way to reduce the cognitive load to some extent was to undertake a significant amount of practice of potential conversations, before and throughout the study. Often, a conversation with one participant led to ideas and possibilities to improve and open up the dialogue in new ways and these would be attempted and developed amongst the team prior to working with the next participant. In the end, for each

Wizard of Oz simulation we found the use of a combination of script and free text very valuable; like Dow we felt that too tight a script would impact significantly on the ability of the wizard to respond effectively to unexpected contributions from participants (cf. Dow et al. 2005). As noted above we also had two wizards to try to reduce the cognitive load as far as possible.

Interesting for the analysis were the points in the conversation when the wizard found it particularly challenging to determine what next to 'say'. For example, making choices about which direction to take the conversation, what level of politeness to use, what information to feed into the conversation, which interests mentioned by the participant to focus on, how to encourage and not be seen to cajole, and so on in order to support learning, while accounting for all of the considerations above. While challenging we found these choices were very valuable to the further development of the tool as particularly difficult moments afforded valuable insight in terms of what the Learning Companion should or should not do or say in specific situations. Indeed, similar to other research we suggest that the video recording of the wizards as well as the participants can be particularly helpful for the analysis of the data as these moments can be very enlightening to observe.

Questions of ethics and research validity arising from the WOz method are also important here. Clearly, the success of the WOz method ultimately depends on effective deception of the participants. Participants have to be misled into believing that they are conversing with an 'intelligent' computer rather than with a person. In experimental psychology, where clear rules are given for the circumstances in which deception may be justified (British Psychological Society 2010), it is a common although still sometimes controversial practice. While some researchers suggest that deception can be acceptable if no harm comes to the participants (cf. Goode 1996), others point out that even if deception does no manifest harm, it deprives participants of free choice and treats them as research tools rather than moral agents (cf. Hunt 1982). In any case, there has been little research into the consequences of using deception in research (Pittenger 2002).

Interestingly, in earlier WOz literature, ethics are acknowledged but rarely problemitised (Höysniemi et al. 2004). Instead, researchers are more likely to write about having to work hard to maintain the deception (cf. Dahlstrom 2001) and see the main problem of misleading participants being the possibility of being found out (cf. Munteanu & Boldea 2000). Others suggest that, whilst telling outright lies should be avoided, providing vague information and allowing the participants to draw their own erroneous conclusions is acceptable (cf. Bernsen et al. 1993). In any case, for most WOz researchers, any ethical problems can be resolved in the post-hoc debriefing sessions during which participants are told of the deception (cf. Taib & Ruiz 2007).

In our study, we were very concerned about the ethical implications of our work; and thought through the issues carefully with the support of various guidelines and literature (e.g. AoiR, 2002; Pittenger 2003). We also gained approval from the relevant university ethics committees. In our experience, all our participants were happy for their data to be used in the study and many wanted to participate in later versions of the study when / if the tool became more developed. This may be because our participants knew a human may be involved at the outset so did not feel "foolish" when debriefed; because they knew all their involvement was recorded so they did not feel that their privacy had been invaded; and / or because we took a great deal of care in making participants feel valued and an essential part of the research process. However, issues of deception and debriefing are complex and constantly need to be renegotiated and explored in future studies of this kind.

Ethical issues surrounding deception also have a clear impact on research validity – the question being whether the deception affects the data being collected and thus skews the results of the study. However, research validity is rarely addressed in the WOz literature, despite the fact that a WOz study might be compromised for a variety of more prosaic reasons: does the prototype technology represent accurately the proposed technology; is the performance of the wizard sufficiently computer-like; and, ethical issues aside, has the deception been effective, has the WOz illusion been successful? These questions need more attention in the future.

Conclusions

In summary, we argue that the use of WOz simulations may be a valuable methodological technique for social science (as well as computer science) researchers who are interested in networked learning. In addition to being a valuable aid in the development of technological tools, it provides a way for academics to be more involved at an early stage with the debate around what kinds of technologies we need for learning and education, and is also another way to better understand learners and how they experience new technologies for learning.

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