LifeGuide: An infrastructure for empowering behavioural intervention research

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1. INTRODUCTION

The study of human behaviour change has been an important theme throughout the history of social science research. In many cases, change in one's behaviour could be beneficial to both an individual and society. For instance, persuading people to cease smoking, to avoid unprotected sexual intercourse, or to eat a healthy diet could potentially improve the health of a population [1]. Behavioural interventions are packages of tailored advice and support for behaviour change, which are known as one of the most important methodologies and technologies adopted by social scientists for understanding and changing behaviour [2]. The advances in the *World Wide Web* have provided a great research platform, which enables many researchers to undertake studies. There has been a trend for more and more behavioural intervention studies to be carried out online [3]. It has been demonstrated that *web-based behavioural interventions* (WBBIs [1]) have many advantages over the traditional face-to-face method [4]. One clear benefit is that WBBIs are able to reach millions of people beyond the restrictions of time and location, which makes studying the change in behaviour of a large group of people feasible. However, at this stage in time, due to the lack of software for authoring WBBIs, their potential is severely restricted. Many commercial applications that could potentially be used for creating interventions have been shown to be inflexible for social science research [5]. Therefore, researchers need to develop WBBI applications and analyse the data of each intervention individually. This vast duplication of effort in producing similar WBBIs, has limited the number of interventions that can be developed and evaluated, thereby limiting the accumulation of knowledge behavioural intervention research. Often, WBBI research projects require the extra cost of hiring software engineers. Once an intervention is deployed, it cannot be easily modified. This hinders researchers in developing and testing WBBIs. Furthermore, evaluating an intervention with an adequate sample can cost over a million pounds [6] – the funding, therefore, stops young researchers from pursuing such studies.

[1] Also known as internet-based behavioral intervention (IBBIs) in the social science community.

LifeGuide is a social science research environment co-designed by both computer scientists and behavioural psychologists for accelerating WBBI research. The system is aimed at enabling social scientists with minimal technical expertise to design, develop and deploy a WBBI by themselves. The intervention and its results can be shared or reused within the research community to devise evolving interventions. The data for each intervention can be potentially integrated to carry out large scale data analysis to answer further research questions.

2. LIFEGUIDE RESEARCH PLATFORM

Traditionally, behavioural interventions are conducted face-to-face, where experts get to know the people they are helping and tailor advice for each individual. WBBIs typically replace this process with adaptive web applications - where experts set a series of questions which appear in interactive webpages and tailored advice is displayed for the subject based on their responses. Often, a WBBI study includes the designing, deploying, piloting and trialling of the intervention as well as data analysis. We aimed to develop a research environment to cover the full scope of this process, enabling a researcher to carry out an intervention study without a computer programmer. Based on this, three major challenges were identified: i) How to enable social scientists with no graphic design experience to create web pages; ii) How to empower social scientists with no programming experience to program the adaptive parts of an intervention; iii) How to provide a research environment which feels familiar to social scientists that will accelerate WBBI research.

Based on these requirements, LifeGuide was designed and implemented. The LifeGuide platform has two major components – a *Desktop Authoring Tool* for creating and editing intervention applications and an *Intervention Manager Web Portal* for recording and analysing the data of the intervention participants. Figure 1 illustrates the process of carrying out a WBBI study with LifeGuide – the researchers firstly create an intervention on their local computer in the authoring tool, then export and upload it to the intervention manager web portal. A trial can be then carried out online. Once an experiment is completed, the data can be exported from the portal for further analysis.

The user interface of the desktop authoring tool was designed to be like Microsoft PowerPoint, allowing social scientists to create a webpage in a similar fashion to

creating their presentation slides. In order to assist the user in creating more professional looking web pages we provide a set of webpage themes and templates. Webpages authored in the tool are then linked together by an intervention logic script. This is a set of instructions to determine the order in which webpages should be displayed, as well as how the questions and tailored advice are presented, processed and evaluated. The logic scripting language, which was co-designed with behavioural intervention psychologists, is based on plain English. For instance, "show advicePage if (page1.question = 'yes')" means display the page named "advicePage" if the user responds "yes" to the question on page 1. We also specially created a set of commands to help provide domain specific functions that are commonly used in WBBIs, such as randomization for constructing *Randomized Controlled Trials*.

Once an intervention is deployed on the intervention manager web portal, all of the intervention participants' data (e.g. participants' responses, the order of pages viewed, the amount of time spent on each part of intervention) are recorded. The portal offers a set of data analysis tools to display the experiment's results and the raw data can be exported to Excel, as this is familiar to many researchers. The portal also provides several social features to enable the communication between both intervention authors and users.

An intervention created in LifeGuide is represented underneath in *IMS Question and Test Interoperability* (QTI) with an *eXtensible Markup Language* (XML) data binding. QTI is a standard for representing assessment content and results, which well fits the requirements of WBBIs. The University of Southampton has developed a series of QTI tools in the past few years, which provided a solid technical foundation for the LifeGuide project [7]. In order to construct an online shareable intervention repository, a Dublin Core based metadata file is bound to an intervention package. This enables a researcher to describe and categorize an intervention as well as clarify the copyrights. With this basis, an intervention can be easily retrieved later on, which creates an opportunity for researchers to reuse existing interventions.

3. CURRENT DEVELOPMENT

To date, there are a number of interventions under development using LifeGuide. One intervention has completed qualitative and quantitative piloting and some of the results of the study have been published. The cost-effectiveness of LifeGuide has been clearly demonstrated in terms of reducing the cost in programming personnel. For example, in one of our previous WBBI projects (a 9 month project on the treatment of multiple sclerosis fatigue), one full-time programmer and one psychologist were required to co-develop a flash-based intervention site. A similar 9 month web based intervention project is now being developed with LifeGuide by one psychologist only. According to our case study, the psychologist claimed that her major needs were in contacting IT support when attempting to create the intervention logic. However, this reliance has been gradually decreasing as the psychologist has learned the basic syntax of the language. This could be reduced further in the future by providing more learning materials for creating intervention logic.

We have conducted workshops in a number of institutions, demonstrating our system and obtaining experts' insights on the future developments of LifeGuide. Our workshops included a "hands-on" demo section which required the participants to create a simple intervention within 30 minutes. This exercise covered the process of creating a simple page, writing the logic of an intervention and publishing it online. Overall, a total of 90 researchers participated in these exercises. The majority of the participants completed the exercise with little or no assistance from the IT support team. Although still in its infancy, the LifeGuide system has already shown to be of great interest to social scientists. Many discussions emerged regarding the possibility of developing particular types of the intervention inside LifeGuide. To date, a total of 144 researchers have joined the LifeGuide network.

4. DISCUSSION AND CONCLUSION

The LifeGuide social science research environment provides a platform to empower web-based behavioural intervention research. Although it has demonstrated immediate benefits to the research community, some challenges remain. From a technical perspective, QTI was not designed to be programmed sequentially as we adapted it in LifeGuide. Another layer on top of the existing QTI library needs to be implemented for this requirement. Despite the fact that the majority of social scientists from the workshops could create interventions with simple logic, we have observed a difficulty in creating interventions with complex logic. The LifeGuide learning material is currently under-development and a graphical programming method is also under-investigation. Nonetheless, we encourage social scientists to create their intervention using the LifeGuide platform at this time. This is because every single intervention authored by the tool will potentially function as a learning material and the intervention repository as a whole will eventually form an "intervention library", therefore flattening the learning curve in authoring logic. As web-based behavioural interventions become widely used in many aspects of life, the data of refined intervention experiments can be integrated into a larger data set. The Semantic Grid can be applied to maximize the sharing and reuse of data. The integrated data will eventually form a foundation for "population laboratories" in the future. The semantically linked data can then be utilized to carry out more powerful analysis to answer new research questions which have hitherto not been possible.

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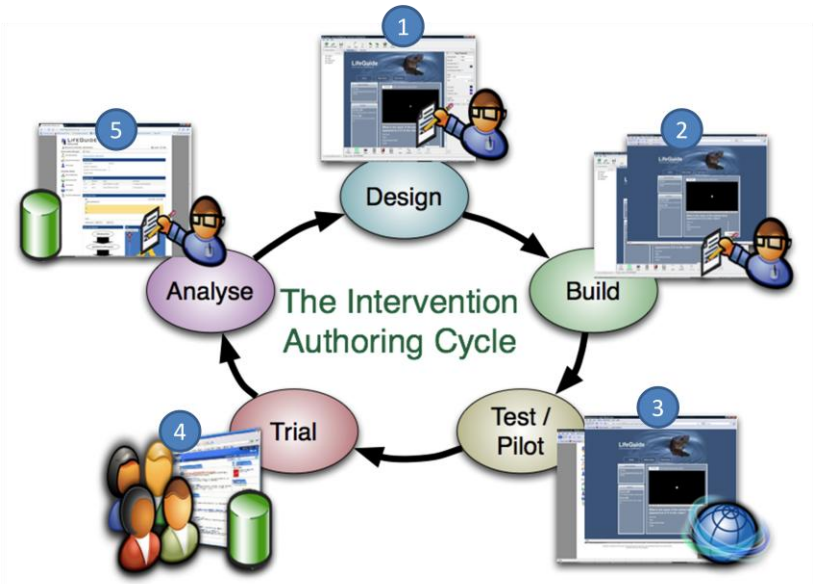

1. Design a *Web-Based Behavioural Intervention* in the *Desktop Authoring Tool*
2. Build and export the WBBI Package
3. Upload the WBBI on the *Intervention Manager Web Portal* for piloting
4. *Intervention Manager* records all participants' data
5. Export data from web portal for further analysis

Figure1. The Intervention Authoring Cycle