LifeGuide: A platform for performing web-based behavioural interventions

Jonathon Hare, Adrian Osmond, Yang Yang, Gary Wills, Mark Weal, David De Roure
School of Electronics and Computer Science, University of Southampton, Southampton, UK
{jsh2|aco|yy4|gbw|mjw|dder}@ecs.soton.ac.uk

Judith Joseph, Lucy Yardley
School of Psychology, University of Southampton, Southampton, UK
{J.Joseph|L.Yardley}@soton.ac.uk

Abstract. Behavioural interventions are a technique used by social scientists and health professionals to mediate the behaviour of a subject. Traditionally, interventions take the form of tailored advice given in a face-to-face setting. Internet-based behavioural interventions harness the power of the web to deliver tailored advice to participants at the time that most suits them. The LifeGuide project is a multidisciplinary collaboration with the aim of developing and proving a set of software tools for the development and deployment of internet-based behavioural interventions. The tools developed in LifeGuide cover the complete lifecycle of an intervention, from initial authoring to trialling and refinement to final deployment. Looking ahead, in the longer term we intend to investigate how the LifeGuide toolset can be applied to other domains.

1. Introduction

Interventions designed to influence people's behaviour ('behavioural interventions') are a fundamental part of daily life, whether in the form of personal advice, support and skills training from professionals (e.g. educators, doctors) or general information disseminated through the media. However, personal advice and support are very costly, and it is impossible to provide everyone with 24-hour access to personal guidance on managing all their problems. General information provided through the media may not be seen as relevant to the particular problems of individuals, and provides no support to help people make desired changes to their behaviour. For the first time, the World Wide Web provides a cost-effective opportunity to provide open 24-hour access to extensive information and advice on any problem. Interactive technology means that the advice can now be specifically 'tailored' to address the particular situation, concerns, beliefs and preferences of each individual, and intensive daily support can be provided for behaviour change in the form of reminders, personalised feedback regarding progress and overcoming obstacles, help with planning, and opportunities for communication with peers (e.g. [1,2]).

In view of this huge potential, web-based behavioural interventions are starting to be developed in the public and private sector [3]. However, currently each intervention is individually programmed from scratch, with the result that the initial development costs are greater for web-based than for traditionally delivered interventions, and once programmed they cannot easily be modified. This seriously limits the number of interventions that can be developed and evaluated, and acts as a barrier to innovation and enhancement of interventions by researchers.

The aim of the LifeGuide project is to develop, evaluate and disseminate a set of tools that will allow researchers to flexibly create and modify two fundamental dimensions of behavioural interventions: providing tailored advice; and supporting sustained behaviour. The LifeGuide toolkit will eliminate the costly waste of resources involved in programming every intervention individually, and will allow researchers to easily test components of interventions and immediately modify and improve the interventions based on their findings. The tools will also increase the number of researchers who can engage in this type of research; opening it up to those with limited funding (e.g. junior researchers and research students). The practical benefit will be more rapid development of better interventions, while the scientific benefit will be a much faster accumulation of knowledge about the effects of different elements of interventions than at present, which will improve our basic understanding of the influences on behaviour.

2. The LifeGuide Software Suite

In the LifeGuide project, social scientists and computer scientists are working closely together to develop the software needed, using extensive expert consultation through workshops and the Internet to obtain researchers' views of how to make the software fit for all requirements. The LifeGuide software essentially comprises of three main components: a web-based player through which end users can access an intervention; a web-based management interface through which researchers can control and view data from their interventions; and a standalone desktop-based authoring tool in which researchers can create and edit interventions. The tools also enable the construction of randomised controlled trials (RCTs) for the interventions.
2.1 A solid foundation – IMS QTI 2.1
The IMS Question and Test Interoperability (QTI) specification [4] is a standard for representing questions and tests with a binding to the eXtensible Markup Language (XML) to allow interchange. The QTI specification describes a data model for representing electronic assessments, consisting of items (pages with questions), tests (the flow between the pages) and the reporting of results. Whilst the QTI data model was designed to represent the traditional assessment domain, it has become increasingly apparent that the model is well suited for a much broader class of assessments. In particular, a behavioural intervention in which questions are asked, and adaptive advice or feedback is provided can be viewed as a form of adaptive assessment, and is modelled well by the QTI specification.

QTI items can consist of multiple questions or interactions with different forms (e.g. text entry, multiple choice, numeric sliders, etc). QTI also defines a model for adaptive assessment in which the current location within an assessment can be defined as a series of pre-requisite conditions or branches. These conditions are defined through a simple, but flexible, programming language that allows the evaluation of arbitrarily complex expressions that are capable of examining previous responses from the user.

The QTI specification forms a base for all the tools built in LifeGuide. In particular, the logic of an intervention is modelled using a QTI assessmentTest, the pages as assessmentItems, and a complete intervention (test, items and other resources, such as images) is packaged as an IMS QTI conformant content package. The content package is basically a zip file with a special manifest file included that describes the contents.

Within an intervention, there are often a number of things that an author wants to do that are not directly covered by the QTI specification; for example sending emails to a user at certain times after they have first logged on to an intervention. These issues are dealt with by extending the QTI documents in a manner defined by the specification, which allows additional functionality to be plugged in.

From a software engineering standpoint, all the support for the QTI specification is encoded in a single open-source Java software library called JQTI1. We began development of the test and reporting parts of JQTI in a previous project [5], and in LifeGuide we have completed it so that the whole of the specification is implemented. In addition to providing a programmatic binding of the QTI data model, JQTI is also an interpreter for the QTI logic, and is able to process user input using the logic defined in the assessment or intervention.

2.2 Intervention Authoring Tool
The LifeGuide authoring tool enables researchers to create new interventions. The user interface is designed to be familiar to users with experience of using tools like PowerPoint to write presentations, but without experience of writing HTML web pages or doing any software programming. The overall authoring scheme is inspired by an old piece of software called HyperCard, which allowed users to graphically construct a “stack” of cards with various buttons and controls, and then author logic for the controls using a scripting language with an English-like syntax.

In particular, in the LifeGuide authoring tool the pages (instances of QTI items) are created in a graphical

![Figure 1: The LifeGuide authoring tool.](image)

1 JQTI information can be found at [http://jqti.qtitools.org](http://jqti.qtitools.org) and [http://www.sourceforge.net/projects/qtitools](http://www.sourceforge.net/projects/qtitools)
emailing
and
Facebook
style
'wall'
for
writing
notes
and
messages
to
collaborators.

The
software
allows
owners
of
an
intervention
to
deploy,
manage
and
query
interventions. Once
a
researcher
has
created
an
intervention
they
can
enter
the
intervention
manager
portal
and
upload
their
intervention
content
package. The
researcher
has
the
option
of
setting
start
and
expiry
dates
for
the
intervention.

In
addition
to
providing
the
ability
to
deploy
an
intervention,
the
manager
software
also
provides
support
for
the
researcher
has
created
an
intervention
they
can
enter
the
intervention
manager
portal
and
upload
their
intervention
content
package. The
researcher
has
the
option
of
setting
start
and
expiry
dates
for
the
intervention.

The
logic
that
determines
the
adaptive
features
of
the
intervention
is
expressed
in
a
simple
scripting
language
inspired
by
xTalk
family
of
languages. The
programming
language
allows
users
to
simply
express
complex
logic
for
controlling
the
movement
between
pages,
and
other
factors
such
as
adaptive
feedback. A
sample
snippet
of
the
LifeGuide
scripting
language
is
illustrated
in
Figure
2.

WYSIWYG
editor
that
displays
the
pages
exactly
as
they
will
appear
in
the
users
web-browser. Figure
1
illustrates
the
user-interface
of
the
authoring
tool
in
page-editing
mode,
and
shows
the
level
of
graphic
design
achievable
with
the
tool.

The
logic
that
determines
the
adaptive
features
of
the
intervention
is
expressed
in
a
simple
scripting
language
inspired
by
xTalk
family
of
languages. The
programming
language
allows
users
to
simply
express
complex
logic
for
controlling
the
movement
between
pages,
and
other
factors
such
as
adaptive
feedback. A
sample
snippet
of
the
LifeGuide
scripting
language
is
illustrated
in
Figure
2.

Behind
the
scenes
in
the
authoring
tool,
a
compiler
process
is
run
to
translate
the
logic
expressed
in
the
script
written
by
the
user
into
a
valid
QTI
assessmentTest
document. The
graphical
authoring
component
creates
QTI
assessmentItem
and
style
files
directly,
however
the
compiler
also
augments
these
with
extra
information.
Any
errors
during
the
compilation
process
are
shown
to
the
user,
and
the
software
attempts
to
illustrate
to
the
user
exactly
where
any
problems
with
the
script
occurred.
When
the
user
is
happy
with
their
intervention
they
can
export
it
to
a
content
package
file,
which
can
be
uploaded
to
the
web-based
LifeGuide
Manager
for
trialling
and
deployment.

2.3 Intervention Manager

The
LifeGuide
manager
software
allows
researchers
to
deploy,
manage
and
query
interventions. Once
a
researcher
has
created
an
intervention
they
can
enter
the
intervention
manager
portal
and
upload
their
intervention
content
package. The
researcher
has
the
option
of
setting
start
and
expiry
dates
for
the
intervention
as
well
as
providing
a
name
that
will
form
part
of
the
public
URL
to
the
intervention. Once
the
intervention
is
uploaded,
subject
to
any
date
constraints,
it
becomes
available
for
use
in
the
intervention
player.

In
addition
to
providing
the
ability
to
deploy
an
intervention,
the
manager
software
also
provides
support
for
the
intervention
during
its
online
lifecycle.
In
particular,
the
manager
is
responsible
for
collating
data
from
the
player
about
the
usage
of
each
deployed
intervention.
The
data
provided
by
the
player
and
recorded
by
the
manager
consists
of
two
main
parts;
session
information
and
report
information. The
session
information
contains
information
such
as
a
users
IP
address
(from
which
a
geo-location
is
derived),
the
time
the
session
started
(when
the
user
first
went
to
the
site)
and
the
actual
date
of
pages
viewed.
The
report
data
is
in
fact
a
QTI
report
generated
according
to
the
specification;
in
particular,
the
report
contains
information
about
the
users’
responses
to
questions
and
how
long
the
user
spent
on
each
part
of
the
intervention.
Some
of
these
features
are
illustrated
in
Figure
3.

The
manager
software
is
capable
of
graphically
displaying
to
a
researcher
how
many
people
used
a
particular
intervention
in
a
given
time
period,
and
how
the
users
were
geographically
located. Researchers
are
also
able
to
dlur

to
the
level
of
a
particular
user
of
an
intervention
and
view
data,
such
as
the
QTI
report,
and
information
about
the
ordering
of
pages
viewed
by
the
user. In
a
future
update,
the
manager
software
will
also
be
capable
of
generating
and
exporting
reports
from
the
recorded
data
over
groups
of
many
users
or
sessions
for
further
analysis
in
external
software.

One
final
feature
of
the
manager
software
is
its
support
for
collaboration. The
software
allows
owners
of
an
intervention
to
share
recorded
data
amongst
other
researchers,
and
provides
collaborative
tools
including
group
emailing
and
a
Facebook
style
'wall'
for
writing
notes
and
messages
to
collaborators.

```
show pagel
if (pagel.type = "beer") set percentage to 5
else if (pagel.type = "wine") set percentage to 12
else if (pagel.type = "liqueur") set percentage to 20
else set percentage to 40
if (pagel.container = "shot") set volume to 25
else if (pagel.container = "sm_wine") set volume to 125
else if (pagel.container = "lg_wine") set volume to 250
else if (pagel.container = "hp_glass") set volume to 330
else if (pagel.container = "sm_bottle") set volume to 330
else if (pagel.container = "md_bottle") set volume to 500
else if (pagel.container = "pt_glass") set volume to 568
else set volume to 750
set alcohol to ( multiply( percentage, volume, pagel.quantity ) / 100)
show page2
set page2.amount to alcohol
show page2.good if (alcohol <= 30)
show page2.reasonable if ((alcohol > 30) AND (alcohol <= 100))
show page2.bad if (alcohol > 100)
```

Figure 2: The LifeGuide scripting language. This example shows some of the logic for an intervention that provides advice about drinking too much.
2.4 Intervention Player

The LifeGuide player component is in essence a generic adaptive hypertext system, augmented with the ability to record specialised usage and timing information. From perspective of the end user, a web-based intervention is accessed through a browser and appears as a series of web pages with questions and tailored advice.

As previously described, the QTI specification is used to store the intervention as a series of XML files. The QTI item files are rendered as XHTML in a web browser by simply transforming them using an XSL transform (XSLT).

It should be noted that the same XSLTs are used in the authoring tool to support the WYSIWYG editor. The actual rendering process is slightly more complicated because internal state often needs to be included in the rendering. Figure 4 illustrates the process taken by the player to render an intervention; all of the internal logic state (of the intervention session) is encapsulated within the JQTI library within the player.

3. Discussion

The development process taken by the LifeGuide team has been very rapid. The aim has been to try and get early release tools into the hands of real users in order to allow iterative feedback throughout the remainder of the project. Within the first 9 months we have completed the construction of the player software, and the first release of the manager component has been deployed to users. A number of beta releases of the authoring tool have been released, with each one adding more features requested by users, in addition to fixing problems. Two interactive workshops have also been run, in which participants have used the complete suite of tools to author, test and deploy a simple four-page intervention. In total, over 50 researchers have had hands-on experience using the tools.
4. Conclusions and Future Work

The LifeGuide project has developed a platform for the creation of online internet-based behavioural interventions. The toolset allows professionals and researchers to manage the complete lifecycle of their own interventions from initial authoring on the desktop to final deployment on the web. Once deployed, LifeGuide interventions can potentially be reached by thousands of users over the Internet. For researchers in particular, the LifeGuide software allows in-depth data capture of exactly how a user is using a given intervention, down to the level of how long they spend on a page and what responses they give for every interaction.

Looking ahead, in the longer term we intend to investigate how the LifeGuide toolset can be applied to domains other than behavioural interventions. In particular, we intend to investigate the use of the tools in the e-assessment/e-learning domain, which is an obvious candidate given the nature of the QTI basis of the tools. Another possible use for the tools is for developing online questionnaires that require adaptivity or wider varieties of interaction than current tools can provide. With respect to behavioural interventions, one future aim is to further develop the LifeGuide tools into supporting a “population laboratory” which will enable the quantitative results from multiple interventions to be shared and analysed together.

Acknowledgements.

The development of the LifeGuide platform is supported by the Economic and Social Research Council (ESRC) through the UK National Centre for e-Social Science (NCESS). LifeGuide is one of the seven NCESS research nodes.

References.