Widgets to support disabled learners: A challenge to participatory inclusive design

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ABSTRACT
This paper describes a combinatorial methodology that responds to the challenge of inclusive design drawing from the fields of participatory design and agile development. We describe the Widgets for Inclusive Distributed Environment (WIDE) study that aims to produce open source widgets that can be plugged into a range of learning environments to support disabled learners and are freely available for use and adaptation by the wider community. The research adopted a mixed methodology by involving disabled learners not just as research subjects but as consultants, designers and partners. We describe the WIDE process in terms of the participants’ involvement. The evaluation findings of the study highlight the importance of a mixed methodology for inclusive e-learning design and contribute to the understanding of HCI approaches in the context of designing participatory studies.

Author Keywords

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
The paradigm shift in the means of interaction with the web is being enabled by the convergence of three trends: the growing number of Internet-capable mobile devices, increasing flexible web content and continued development of the networks that support connectivity (EDUCAUSE Horizon Report, 2011). The challenge and potential to connect and mash up different Web based applications and the considerable growth in the widgets/mobile applications market, are driving the impetus to go beyond the traditional virtual learning environment and to adopt the concept of a Personal Learning Environment. Students are now familiar with online systems such as the BBC website or iGoogle which offer a high degree of personalisation in the functionality that can be selected, the appearance of content and the ways in which users can present themselves to others. In terms of educational use, students should be empowered to manage and organize their learning environment and customise various decentralised learning applications and services on the web, according to their own needs. A combination of different widgets can serve as front-end applications for distributed learning aids and services in a mash up based personal learning environment (Taraghi et al., 2009). Widgets can also represent discrete tools, applications, assistive technology or other learning supports to perform specific functions. In the context of the research reported here, a widget, is considered as a discrete, self-contained application that works across a range of browsers or platforms (Pearson et al., 2011). In terms of widgets to support disabled learners, examples include widgets that support learners with motor difficulties in completing web forms, widgets for creating high contrast view/themes or activating voice recognition for students with vision impairments, or symbols-based calendars for students with learning disabilities or cognitive disabilities that are non-text users.

This concept of mash up personal learning environments that allow the learner to select and configure their own set of widgets is particularly pertinent in terms of meeting the needs of disabled learners that have particular and
BACKGROUND RESEARCH

The global learning landscape of the twenty-first century is being transformed and shaped by the uptake of digital communication tools and ubiquitous networked applications, along with the changing characteristics, needs and demands of students (McLoughlin & Lee, 2009). Selwyn and Facer (2007) argue that ‘every individual is entitled to be able to make informed and empowered choices about the uses of ICT whilst having ready the resources required to enable them to act on these choices’ Nevertheless, a recent survey on the e-learning experiences of disabled students in HE (Seale et al., 2010) has highlighted an ‘all or nothing’ approach to assistive tools, in which you either have the technology or not. Furthermore, when students with disabilities use proprietary access technology, they have little or no way to adapt it or select individual components to suit their own needs. For users with disabilities, as for all other users, free or open source software offers the opportunity for users to control their own computing, to make software fit their needs rather than passively accepting whatever developers choose to offer them.

The widgets, gadgets and (mobile) applications market has had considerable growth over the past several years, as we turn to mobile applications for immediate access to many resources and tasks that once were performed on desktop computers. These emerging technologies provide an opportunity for the creation of small, bespoke widgets that perform specific functions and act as assistive technology and learning aids to support learners with disabilities.

Despite the growing popularity of the widgets, apps or gadgets, (WAGs) market, in education the opportunities for choosing such applications is limited and there is no specific category for education or for accessibility. Furthermore, WAGs are often proprietary and application specific. Nevertheless we acknowledge the danger of systems designed specifically to support disabled learners is that they can be costly, and may be limited in their potential for sharing and re-use. Secondly the expertise and best practice of local practitioners producing specific solutions is difficult to identify and adopt by the wider community (Sampson & Zervas, 2010). For this reason, the aim of this research is to make widgets that meet specific needs, but at the same time could be easily adapted to suit other specific needs. The intention is not to provide a wholesale solution, but rather to support the use and development of widgets individually, or in collections of other widgets and learning resources.

WIDGETS FOR INCLUSIVE DISTRIBUTED ENVIRONMENTS (WIDE) PROJECT

This research integrates participatory design and agile development approaches through a project funded as part of the JISC Distributed Learning Environments initiative: Widgets for Inclusive Distributed Environments (WIDE). WIDE is a joint project that comprises accessibility experts, academics, researchers, teachers, tutors and other practitioners from the Higher, Further and Specialist College education sectors. The project aims to develop resources that extend the functionality and flexibility of virtual learning environments to meet the needs of learners with disabilities who may require their learning resources to be adapted to meet their specific needs (MacNeil & Kraan, 2010) and contributes to the vision of an adaptable and personalized learning environment (Pearson & Gkatzioudou, 2010). The study adopted a participatory approach in that it enabled researchers and technologists (WIDE team) to work together with disabled students and practitioners (in teaching or support roles), to identify a student need, and to explore the issues and impacts of potential solutions to that need. The ideas were then translated into a design document, which represents a learning design for a widget that will best support the student. The WIDE development team then adopted an agile development approach to produce iterative
prototypes of the widgets in close cooperation with the designers to develop a bank of high quality widgets that can be plugged in to a range of learning environments, created by and for those responsible for supporting disabled students in further and higher education and in specialist colleges.

PARTICIPATORY APPROACHES IN E-LEARNING RESEARCH

Participatory design is commonly used in the fields of human computer interaction and computer science, and incorporates the related fields of inclusive design (Dewsbury et al., 2004); co-design (Druin, 2007) and user-centered design (Newell et al., 2007). It can be defined as active involvement of users throughout the entire research and development process (Hanson et al., 2007) and is generally understood to involve working with users, early and continual participation of users, engaging with real users in their real contexts, iterative cycles of development and evaluation until an agreed solution is reached and collaborative partnerships between users and designers.

Within the HCI community worldwide, participatory research is commonly used in disability studies research, (Moffatt et al., 2004), (Wu et al., 2005) as it provides for an effective technique for bringing users concerns directly into the design process. There are fewer examples however of students being involved in participatory design related to e-learning, as most efforts have been focused on the design of assistive technologies, rather than designing learning experiences.

AGILE DEVELOPMENT

The agile approach to software development is not a single, well-defined process, but a common name for several processes and methods, sharing a set of core ideas, values and principles of software development (Blomkvist, 2006). The core values and principles as defined in the Agile Manifesto (Agile Alliance 200) place less emphasis on the process and its deliverables, and focus instead on the people involved and their co-operation in order to produce results more quickly with reduced risk of failure or delays. The driving force behind the agile perspective is to shift the overall focus of software development to a more agile or lightweight perspective (Cockburn 2002). For this reason, agile methods provide a lightweight approach to development where requirements and solutions evolve through collaboration and through iteration. The nature of widgets lends itself to agile iterative methods (Leeder, 2009) as a basic functional widget prototype is straightforward to develop and deploy to users in a series of design iterations. Nevertheless, from an HCI perspective, agile processes do not inherently provide the required support for user-centred design, but can function as one pillar on the way to an integrated approach (Memmel et al., 2007).

THE WIDE Methodology

The WIDE project adopted a mixed methodology that draws on principles from participatory design and HCI under the umbrella of agile development. This methodology responds directly to the call for methods that empower learners to be the ones who highlight the issues which are important to them (Sharpe et al., 2005). The use of this mixed methodology distinguishes the project from other studies that have researched the experiences of disabled learners, in that participation is conceptualised as involving them more than as research informants.

In addition, we also utilised the JISC Users and Innovation Development Model (JISC UIDM, 2007) that identifies and promotes the application of next generation, emergent technologies (in social media, ubiquitous computing and personalised environments) for education, through the establishment of an agile, user-focused development community.

The combination method we employed enabled the mapping of the user centred approach of participatory design to the agile development method throughout the project lifecycle. The approach (Figure 1) identifies Users (U), Innovators (I), Developers (D) and Modelers (M).

![Figure 1: The UIDM model](image)

In the context of the WIDE project, the users are the students, the innovators are the researchers, the developers are the technical experts and the modelers are the teachers.

Participatory design can be defined as an approach to design that attempts to actively involve all stakeholders in the design process to help ensure that the product designed meets their needs and is usable. For this reason, in addition to adopting a process that enabled the participation of disabled learners, the WIDE project enabled the participation of a wider group of stakeholders (Table 1).
Stakeholders | Interest/Stake
--- | ---
Disabled students | Creators and end users with specific needs.
Teachers of students with disabilities | Users of widgets. Established needs for flexible solutions to student support learning.
Researchers | Understand issues of e-learning development to support personalisation and accessibility.
Tutors/Carers | Understand needs of disabled learners.
Practitioners from HE, FE, Specialist Colleges | Need to understand how widgets can be used to provide flexibility to VLE.

Table 1. Stakeholders Table

In terms of the degree of participation involvement, research demonstrates a wide spectrum that ranges from non-involvement to participant-initiated. Radermacher (2006) identifies six categories of participant involvement, ranging from non-involvement to participant-initiated, shared decisions with researcher (Table 2).

The WIDE methodology conforms to the category defined by Radermacher as “researcher-initiated, shared decisions with participants” where the researchers have the initial idea for the research, but participants are involved in every step of the planning and implementation’

Table 2. Degree of participation involvement

<table>
<thead>
<tr>
<th>Degrees of participant involvement</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-involvement</td>
<td>Project is designed and run by the researcher</td>
</tr>
<tr>
<td>Assigned but informed</td>
<td>Researcher chooses research topic and participants volunteer to be involved.</td>
</tr>
<tr>
<td>Consulted and informed</td>
<td>The study is designed and run by researcher but participants are consulted.</td>
</tr>
<tr>
<td>Researcher initiated</td>
<td>Researcher has idea but participants are involved in every step and are involved in taking decisions.</td>
</tr>
<tr>
<td>Participant initiated shared decisions with researcher</td>
<td>Participants have the ideas, set up the study and research offers expertise.</td>
</tr>
<tr>
<td>Participant initiated and directed</td>
<td>Participants have the idea and decide how the study is to be carried out.</td>
</tr>
</tbody>
</table>

With regards to the participation of users and stakeholders in the WIDE study, there were three key phases of participation:

- **Phase One**: Opportunity to contribute own experiences of e-learning and identify potential tools to support their learning.
- **Phase Two**: Opportunity to conceptualise and design the widgets to meet the identified needs.
- **Phase Three**: Opportunity to evaluate their ‘own’ and other widgets developed.

In the first phase of the study and in preparation for the workshop, the teacher participants were invited to identify with their students what they think would be the most useful means of support in terms of widgets. In the case of tutors working in specialist colleges with students who are not always able to articulate their needs, then the tutors would contribute their own ideas from direct experience of supporting their students.

In the second phase of the study, the participants were involved in producing learning designs to encapsulate their ideas for widgets. In the third phase of the study, different stakeholders evaluate different aspects of the study; users evaluate the widgets they have designed, disabled students who have not been involved in the workshops evaluate the widgets and external consultants evaluate the process of setting up and supporting the community of practice. Each of these phases will be described in detail in the following sections.

**WIDE Pre-Workshop participation (PHASE 1)**

Teachers and students discuss the problems and difficulties the students experience in using the VLE, organising their work, carrying out assessments or completing assignments. They identify the kinds of tools that would help them to achieve these tasks or support their learning. These discussions would be encapsulated later on in the Phase 2 workshops in the form of personas and scenarios, so that, although students may not be directly involved in that phase, their requirements are captured.

**WIDE WIDGET DESIGN WORKSHOPS (PHASE 2)**

During the second phase of the project, through a series of workshops and follow up activities, the participants were given the opportunity to identify appropriate learning designs (digital and non-digital) derived from practice that can be re-purposed as widgets.

The WIDE workshops were run on three separate occasions at three different locations, at Teesside University, at a specialist FE college in Mansfield, and at
The workshops involved a total of 11 teams of four to six people (49 participants in total), with an average of 15 participants at each workshop. During the workshops, participants were divided into groups of five, where each group would include a disabled student, an academic/teacher, a researcher, a tutor/carer, and practitioner where possible in order to obtain detailed and highly contextualised learner voices. Each group was assigned to a developer and was facilitated by a member of the WIDE team, whose role would involve bringing together the diverse expertise of the participants and overcoming the common challenges of participatory design in terms of gaps in communication (Segalowitz et al., 2010) and alignment of expertise with the community (Nwigma, 2009). The outline of the workshops included:

- Overview of open source and freeware accessibility software
- Introduction to creation and use of mobile prompts
- Widget design brainstorming in small groups (including design facilitators)
- Working collaboratively on poster templates to create designs in small groups
- Presentation and discussion of designs
- Widget development and evaluation plans

At the workshops, participants were introduced to examples of learning supports, briefed and prepared for the activities. The brainstorming session elicited a number of ideas (typically six or seven from a group of four) from which the groups then select one or two to develop full designs.

During the design process each group developed their initial ideas further with the aid of a set of specially adapted templates learning design and storyboard templates. For these we used A0-sized laminated posters (Figure 2) in order for the participants to organise their expert knowledge to produce a learning design that encapsulates the necessary information on the interface and functionality of the widget. These posters templates were designed to be user-friendly, requiring no technical expertise and therefore suitable for our participants and suggestive rather than prescriptive. They include some simple prompts and principles, from which ideas can be developed and knowledge can be captured and expressed.

The Widget Learning Design Template provides all the necessary information on the interface and functionality of the widget. It consists of a number of sections that the participants need to complete to describe the widget in detail. Participants were required to complete the following sections on the template:

- **Persona**: a precise description of a typical user of the widget and identifies what the user needs to accomplish
- **Scenario**: identifies the learning context in which the widget would be used
- **Learning Design**: describes exactly what the widget will do and how it will operate
- **Content**: identifies any additional resources or assets that would be required for the widget. For example a ‘calendar widget will require the designer to provide a list of events
- **Links**: identifies any external service the widget might need to be linked to. For example a mobile widget using GPS
- **Related Ideas**: participants are encouraged to identify any small possible adaptations that can be made to create an alternative widget
- **Warranty**: a short statement signed by the designer to license the work under the Creative Commons License

The storyboard template allowed the participants to document and design the interface of the widget. In some cases, participants were required to provide information not only for the user interface of the widget but details on the design and functionality of the administrative side. On completion, the learning designs were photographed, archived digitally, and made available on the WIDE wiki where the final widgets are available for download and distribution. This approach was adapted from the learning object design approach used by the Reusable Learning Objects-Centre of Excellence in Teaching Learning (6).
However many of the elements such as personas and scenarios are commonly used in user-centred design or user-experience design.

**Widget Development**
A total of 31 widget designs were produced during the WIDE workshops, which meant that each team produced more than one design. These designs include a wide range of widgets such as:

- Visual shopping list widget that provides symbol-based task list (Figure 3)
- Digital abacus, a learning aid widget to assist students with motor difficulties in their math calculations (Figure 4)
- Sentence jumbler widget that shuffles the words in a sentence requiring the user to put them in the right order
- ‘I am here widget’, a widget that allows the user to report that they have arrived at a specific location
- ‘Ruler’, is a simple widget that supports dyslexic students reading and tracking text

The widgets were most commonly classified as tools (61%) with around a third (26%) being considered as applications and only a few were classified as learning objects (13%), as shown in Table 4.

<table>
<thead>
<tr>
<th>WIDE Widgets</th>
<th>Tools</th>
<th>Applications</th>
<th>Learning Objects</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tools</td>
<td>19 (61%)</td>
<td>8 (26%)</td>
<td>4 (13%)</td>
<td>31 (100%)</td>
</tr>
</tbody>
</table>

Table 4. WIDE Widget Classification

The designs identified by the participants included a wide range of different types of widgets – all designed to meet particular needs - categorised as time management widgets (13%), task management widgets (16%), assistive technology widgets (16%), learning aids (16%), independence tools (19%), social network widgets (3%), content-free apps (3%) and learning objects (13.5%) (Figure 5).

This classification by widget type simplified the development process - the development of one type of widget provided a template which could be easily adapted to produce other widgets of the same type. For example, the ‘Touch Screen’ Timer allows students to set an alarm for any situation where quick time management is required. The ‘One click’ Timer is a widget that helps learners schedule time for complex sequences. In practice, the ‘One click’ timer is just an adaptation of the ‘Touch Screen’ timer.

As each widget was developed, a liaison from the WIDE
development team contacted the designer to seek clarification or request additional content and invite feedback on the widget (design, interface, functionality etc). This ensured that the designer was aware that ‘their’ widget was being developed and that they were involved in the whole process.

The intention was to develop W3C standard, free, open source widgets that can run in any web browser, do not require installation and are platform independent. Apache Wookie (Incubating) is an application that provides a W3C-compliant widget server where you can deploy widgets and serve W3C widgets from the Wookie server in third party applications. The intention was to develop Wookie (2010) widgets but in some instances this was not feasible, particularly if the widget required access to the desktop or local device.

Following the design process, each of the widgets were classified in terms of a number of factors grouped into technical elements (such as whether they needed access to a database, web-services, operating system or GPS) display features (widget window, desktop, full-screen, movable, resizable, dockable etc) and application compatibility (such as to mobile device, browser or VLE). These features determined the development platform of the widget.

As a result, three types of widgets were developed:

- **Wookie widgets:** standard W3C widget running from a Wookie web server.
- **Opera widgets:** standard W3C widget but benefitting from installation on a desktop or devices hosting the Opera web browser
- **Mobile, desktop or windows app:** designed primarily to install and run on a specific mobile phone or device, laptop or as a windows app and therefore usually not W3C-widget compliant

In practice, the majority of designs (23) were implemented as Wookie widgets, while some (8) required facilities that weren’t available to the widgets standard APIs so needed to be Opera (6) only or Windows apps (2).

**WIDE EVALUATION (PHASE 3)**

In accordance with the UIDM model, evaluation took place at each stage as follows:

- Analysis and design stage: Accessibility experts and technical experts evaluate and advise on proposed designs.
- Implementation stage: Evaluation of prototype widgets by designers
- Deployment: Widgets evaluated in practice by designers (post project)
- External evaluation: an evaluation of the widgets developed, the design approach and the potential for adaptation is being carried out by accessibility experts external to the project.

A full evaluation of the widgets in use is necessarily a longitudinal process and is ongoing.

**Evaluation at Analysis and Design Stage**

Although the primary stakeholders of this study are the students, the teachers and supporters of students with disabilities and accessibility experts were also considered as stakeholders. For this reason, it was important to seek informal feedback on the workshops from the participants and partners at Portland and York. Some comments include

‘In terms of the workshops themselves, I thought that they were superb. It was great to have the morning to contextualise the aims and objectives and then the afternoon for the participants to be creative and work on specific (and therefore highly relevant) widgets’

The workshop facilitator at Portland College gave this view of the experience:

The dynamics of the three workshops were all very different, with pros and cons to each. The mix of the audience in York was superb, with ideas being adapted and changed from ISC to FE to HE and vice versa. In complement to this though, specific groups also formed on occasion to produce a level or user-specific app.

Feedback from staff at Portland also indicated that they enjoyed the control of being authors, especially when there was no need to have the technical expertise to worry about how to produce the widgets themselves.

**Evaluation at Implementation Stage**

A preliminary evaluation of the widgets has been carried out and initial results confirm that the designers are enthusiastic about their widgets, generally the learning designs have been translated successfully into widgets and they have met the expectations of the designers.

A total of 13 participants took part in the evaluation and evaluated the widgets they have designed.

A selection of the feedback and suggestions for further development (some of which has already been implemented) is given below:

**Touch Screen Timer widget:**

‘It's excellent! Well thought out. I like the digital display going red during the last 5 seconds’
Visual Shopping List widget

‘I like the idea of audio feedback on choice selection and selected items put into basket.’

Digital Abacus widget:

‘This is very impressive. Thank you for bringing my idea to creation. The widget works fine and is very close to how I imagined it to work. Could you make the background of the application transparent so the user can see the other ‘open’ window behind the abacus?’ (This was implemented).

Sentence Jumbler widget:

‘First of all let me say that the Sentence jumbler is a really nice idea and I like how quickly it works - no waiting for too long. I think that if I was going to use this with a learner it would be useful to be able to generate more than one sentence at a time for the learner and click jumble and leave them to it for a few minutes’

(Dyslexia Tutor)

The widgets have been widely disseminated and we have already had a request for an adaptation to the Visual Shopping List widget:

‘When I saw the Visual Shopping List in the JorumOpen listings I knew it was something I should show to the teachers. They like the widget very much and have asked me to try and find out if it can be adapted. Their particular idea is that the teacher would be able to type in weights and specify exact brands, where necessary, to allow the system to be used within cooking classes where students visit the catering store to collect their ingredients.”

Evaluation at Deployment Stage

A preliminary evaluation of the widgets developed was also carried out, where selected widgets were evaluated by disabled students in practice. These students have not been involved in the workshops and they were given a list of widgets from which they could choose one to download and evaluate. The data collection method that was employed was a questionnaire that included both rating scale and open ended questions. The students were required to comment on the widgets’ functionality, suggest how they would use them, and identify possible adaptations to their design, functionality or purpose. Overall, the feedback for the widgets was positive and the students identified a number of possible adaptations to the widgets. All of the students found the process of downloading the widget straightforward and easy and only one of the students had difficulties in understanding the purpose of widget.

A selection from the comments from the open ended questions is given below:

Spell it widget

‘This is great for anyone with learning difficulties when it comes to spelling. As a dyslexic myself, this is a great tool. All you have to do is guess how to begin spelling the word and the widget does the rest for you!’

Visual shopping list widget

‘The widget is quite simple to operate but I would have liked some kind of table with the items on to be generated after the done button is clicked’.

One-Click timer widget

‘I expected a simple and easy to use widget with a basic but usable interface, but I was actually unable to get it working at the beginning. I would have liked the option of adding multiple alarms’.

The other student also commented on the interface of the widget.

‘I would use this timer when working on small tasks – especially in a time critical environment. But I tried clicking and dragging the timer bar but instead it dragged the whole application and I would have liked a solid background to it so it won’t conflict with my desktop’.

External evaluation

In terms of the external evaluation, the intention was to receive feedback from accessibility experts external to the project on the validity of our overall process which is relevant in terms of the participatory method applied.

For this reason, we engaged a number of accessibility experts to evaluate the overall process of the WIDE project, in terms of the wiki, widget learning design and implementation method and the widgets themselves. This evaluation covered an evaluation of a sample of three WIDE widgets, an evaluation of the process of developing a widget (from a non developer point of view and from a developer point of view) and an evaluation of the WIDE wiki as a means of supporting the participatory design process (WIDE Project Report, 2010)

In terms of the widgets, the evaluators found that the working versions of the widgets show significant potential in addressing accessibility issues, and matched the learning designs.

Regarding the participatory process, the evaluators identified that the wiki-based approach adopted by WIDE offers a suitable basis for bringing together and supporting interested parties to design and develop widgets. Nevertheless they commented that it was limited
to supporting the community of practice and the workshop participants, rather than the wider community.

**DISCUSSION**

The WIDE project offers a case study in the integration of participatory and user centred approaches under the umbrella of agile development. Drawing from this process and evaluation findings we would argue that through the combination of participatory and agile development approaches we have managed to encapsulate detailed and contextualised learner voices and produce bespoke widgets as a result. Although evaluation of the WIDE project has been restricted to feedback from the CoP designers on the extent to which the widgets meet their design requirements, the positive results of a preliminary evaluation of the widgets in context by disabled students highlight that the WIDE process has been effective in responding to the needs of disabled students. Preliminary evaluation results from designers within the CoP, disabled students external to the process and accessibility experts highlight that the methodology was successful in involving a community of practice in the development of inclusive learning tools and services and eliciting detailed widget design ideas for rapid prototyping.

On reflection, a number of limitations and challenges in regards to the process have also been identified. In some instances, widget designs where not completed in detail within the timeframe of the workshop, which required further input from the participants and resulted in communication problems. Most of the groups at the workshops have produced more than one widget design, which resulted in delays in terms of producing the prototypes and slowed down the agility of the process.

Despite these limitations, the WIDE project did meet its major objective of successfully involving a community of practice in the development of inclusive learning tools and services. The method was very effective in eliciting detailed design ideas for rapid prototyping; in the best case a widget would be proposed, design and built in the space of two days; in most cases this would still be less than two weeks.

**CONCLUSIONS**

Linked to the overarching aim of enhancing the e-learning experiences of disabled learners, the WIDE project aimed to apply user-centred methodologies to the design of accessible widgets and to disseminate these widely, in order to promote a participatory approach to designing and evaluating e-learning.

Web 2.0 technologies equip educators with a rich repertoire of services and applications to address this challenge by enabling learner choice and allowing creative decisions about how to best to set learning goals and create learning environments that support those goals. The findings of the WIDE case study demonstrate a need for personalised applications to enhance the learning experience of students with disabilities, they also recognise that although basic widgets are simple for those with some technical expertise to develop, the development of new widgets is likely to be beyond the means of most teachers or tutors. For this reason a set of authoring tools incorporating libraries of templates, services and APIs and a repository that would enable academics without technical skills to develop, modify, adapt and share widgets is required.

Development of such a toolkit would require extension of the CoP to include developers, content providers, researchers and learning design experts as well as teachers, tutors and students. This represents a significant challenge but would provide a means for a much more extensive CoP to develop widgets tailored precisely to the needs of disabled students, and would make a considerable contribution to emerging models for supporting greater levels of personalisation and customisation of learning for all individuals.

**REFERENCES**


