A community approach to the development of widgets to support personalised learning for disabled students.

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The rapid pace of change of the knowledge intensive era, supported by the emergence of Web2.0 and the consequential growth of personalised applications, has fuelled debate on the notion of Personal Learning Environments (PLEs). The concept of personalisation, adaptability and accessibility is particularly pertinent in terms of creating a learning environment that meets the individual needs of disabled learners that cannot be met by standard approaches and could affect the student's ability to access learning at all. This has led us to explore the potential of the personalised development of learning applications to provide the choice of tools, applications or services to support the learning experience of disabled students. This paper examines a community approach to the design, development and evaluation of open source widgets, through a project funded as part of the JISC Distributed Learning Environments initiative: Widgets for Inclusive Distributed Environments (WIDE).

Keywords: accessibility, widgets, community of practice, personal learning environments

Introduction

Developments in Web 2.0 and cloud computing bring new opportunities for selecting and using tools to support communication, self organisation, independence and self regulation. 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). This transformation is supported 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). At the same time, the rigidity of established learning management systems (LMS) is being challenged by the potential to connect and mash up

different web based applications and the considerable growth in the widgets/mobile applications market. The concept of a mash up Personal Learning Environment that allows the learner to select and configure their own set of applications is receiving considerable attention. This is particularly pertinent in terms of meeting the needs of disabled learners who may have very individual needs that may render standard interfaces and environments inaccessible and affect the students' ability to access learning.

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. Students who use proprietary access technology have little or no way to adapt it or select individual components to suit their own needs. Free or open source software offers the opportunity for disabled users to take control of their own computing, to select software fit their needs rather than passively accepting whatever developers choose to offer them. Focusing on enhancing the e-learning experience of disabled learners, this study explores the design and development of small discrete applications and tools that support the, sometimes, very specific requirements of learners, in an attempt to move closer to the goal of inclusive, accessible and personalised learning.

Widgets for Inclusive Distributed Environments (WIDE), a project funded as part of the UK JISC Distributed Learning Environments initiative, explored the potential of widgets as a component of a mash up personalised learning. It begins by discussing the potential of widgets in enhancing the learning experience of disabled students by offering support in terms of personalised assistive technology tools and learning aids. The paper continues with an overview of participatory approaches in e-learning and then goes on to describe a mixed methodology for the design of widgets to support disabled learners that draws on principles from participatory design and agile development methodologies. Each phase of the study is presented and discussed in terms of the participants' involvement. The findings of a preliminary evaluation of the widgets developed as a result of the project is presented and the paper concludes with a discussion of further work required to support the wider creation and adoption of widgets to support disabled learners.

Background Research

Advances in technology supported by the emergence of Web2.0 and consequential growth of personalised applications, has fuelled debate on the notion of Personal Learning Environments (PLEs). This means that software applications need no longer be monolithic and can naturally be separated into distributed components (Raman, 2008). The application logic and the data resides in the network cloud, while the presentation and interaction can be presented to the user in a form suited to the user's needs. The concept of a Mash-up PLE is to provide an open set of learning tools for the users to gather as they see fit in order to build his own environment rather than offering a monolithic platform which can be personalisable or customisable by users (Wild et al., 2008). The third model of the JISC CETIS models of Distributed Learning Environments (DLE) (MacNeil, S. & Kraan, W. 2010) illustrates an example of how a mash-up of a variety of sources can provide personalisation through the use of different services gathered within a Virtual Learning Environment (VLE).
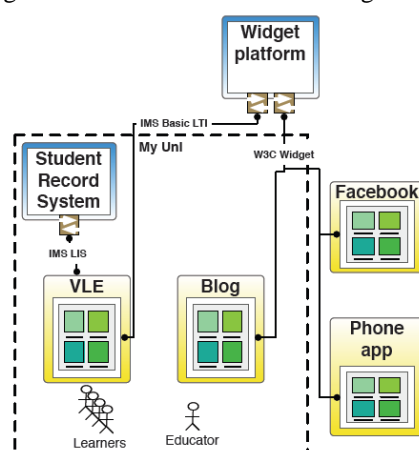

Figure 1. JISC CETIS model of distributed learning environments (Model 1)

The diagram (Figure 1) illustrates one possible instantiation where a single hosting service 'in the cloud' serves a collection of educationally useful, standardised widgets to a VLE, a blog, a social network and a smartphone app. A collection of services is gathered in one place and from there broadcast to a range of platforms.In terms of this project, we have identified the need for an additional platform that, in a Community of Practice development approach, might exist parallel to the Widget Platform. Widgets –especially those created to meet the specific needs of disabled students who may require particular adaptations – are dynamic and not necessarily static in content or structure.

This concept of distributed learning environments, led to new ideas in the e-learning community to promote adaptability and personalisation of virtual learning environments especially for adaptation to specific needs and preferences. The experience of using a set of widgets in a learning environment supports the concept of mash-up PLEs in that it allows students to use applications or tools as they see fit. A mashup 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). The way widgets are conceived promotes the granularity of web applications, which in terms of e-learning means a more adaptable, flexible learning environment.

Widgets 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). The widgets, applications and gadgets (WAGs)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.. In education, though, the opportunities for choosing and using such software are limited. A quick search of the Opera widget site (http://widgets.opera.com/category/) and Google gadget site reveals no specific category for education or for accessibility. (http://www.google.com/ig/directory?synd=open). 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. 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.

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 as WAGS are often proprietary and application specific. 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 personalised learning environment (Pearson & Gkatzidou, 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 potential 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 produce a bank of high quality widgets that can be plugged in to a range of learning environments, developed by and for those responsible for supporting disabled students in further and higher education and in specialist colleges.

THE WIDE Methodology

The WIDE project adopts 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). 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. In the context of the WIDE project and in order to avoid the dangers and pitfalls of a technology-driven pedagogy (Salaberry, 2001), the community of practice involves disabled students, researchers, technical experts, teachers and specialist teachers.

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

Nevertheless, it's the use of participatory design together with agile development methodology that 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. Agile 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).

With regards to the participation of the community of practice 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 Community of Practice (CoP) was involved in producing learning designs to encapsulate their ideas for widget. 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 JISC TechDis in York). 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). Wenger (1998) indicates that leadership and facilitation roles are crucial to all CoP and that should be filled by "recognised experts [who] need to be involved in some way, even if they don't do much of the work", and that their presence is needed to legitimise the community "as a place for sharing and creating knowledge".

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 and 3) 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.

Figure 2 and 3. Widget Learning Design Template and Storyboard

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 fill in 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

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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 (Leeder, 2009). 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 4).
- Digital abacus, a learning aid widget to assist students with motor difficulties in their math calculations (Figure 5).
- 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.

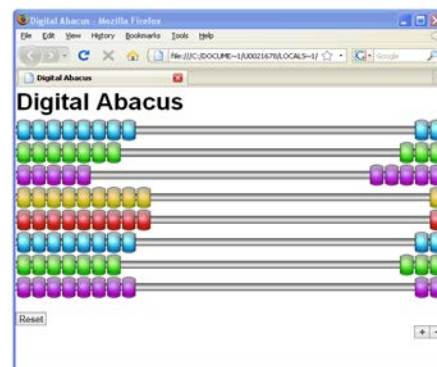**Figure 4. Visual Shopping List Widget**   **Figure 5. Digital Abacus Widget**

The widget designs were classified into three categories:

- Tools: self-contained widgets that might require access to a Web service but do not store or   edit data.
- Applications: complex widgets that use Web services to store and retrieve persistent data.
- Learning Objects: independent self standing units of learning content.

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%).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%).

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 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. Although the original intention was to develop Wookie (2010) widgets, in some instances this was not feasible, particularly if the widget required access to the desktop or local device.

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 applications (2).

WIDE Evaluation (Phase 3)

In accordance with the principles of participatory design, the CoP was involved in every stage of the evaluation:

- 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 the specialist college 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 feed back 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 give a list of widgets they could chose from 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 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 opting 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.

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.

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