

## JISC DEVELOPMENT PROGRAMMES

### ISIS Toolkit Utility, Usability and User Evaluation Report

#### Project

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## **Scope**

The ISIS project outputs include a java library and a web service both of which implement the IMS Simple Sequencing Service. The Simple Sequencing service is itself a relatively untried standard and so we considered it useful to include an evaluation of the standard itself within the remit of this report. Indeed, since the ISIS service has proved during the evaluation to be a faithful implementation of the standard so far as this is possible, the interesting user questions all relate strongly to the usability of the standard itself.

I'll expand on that last point.

If you are interested in whether the ISIS toolkit provides a good usable implementation of IMS Simple Sequencing for programmers, then read no further. *Yes it does*. Refer to the Software Quality Evaluation for further details. At time of writing the ISIS implementation is probably the best available implementation - and at least for UK HE/FE institutions - the cheapest.

If, however, you are concerned to know whether IMS Simple Sequencing is going to be applicable in your institution, then read on. We learnt quite a lot about its relevance during the course of building this demonstrator.

## **The Users**

The *end users* of the ISIS toolkit are:

Institutional Educational Service Providers  
Systems Administrators  
Content Developers  
Teachers and Lecturers  
Learners

However the *direct users* of the ISIS toolkit are programmers.

Perhaps the key finding of this exercise has been that a lot of work is needed to bridge the gap between end users and direct users.

## **The Evaluator - NRICH**

I have carried out the evaluation for NRICH – a long standing publisher of online mathematics resources aimed at schools and jointly supported by the University of Cambridge Faculties of Mathematics and Education. The NRICH team includes Systems Administrators (Owen Smith), Teachers and Lecturers (Charlie Gilderdale, Joe Scholten, Jenny Piggot) and Content Developers (myself – Mike Pearson). NRICH has an outward facing role, providing educational services to schools and the general public rather than to a single institution. Our learners are remotely situated. The NRICH web site can be found at <http://nrich.maths.org>.

One of the prime motivations for NRICH in taking on this project was to discover whether it was possible to use IMS Packaging along with IMS Simple Sequencing in order to implement a long standing need to provide structured ‘trails’ through the resources on the NRICH web site.

Some background is perhaps necessary here. The NRICH web site is published once a month. Each issue contains about 16 problems in mathematics designed to enrich the normal school curriculum. These are published with notes for teachers, hints for students, and links to discussion boards and an edited sampling of correct solutions received from students for the previous month’s problems. This means that the site has, over the years, built up a large archive of small resources. These could benefit from being sorted, organised and sequenced into larger packages each with their own learning objective.

### ***Why not use IMS Learning Design?***

Analysis of NRICH web logs suggests that over 60% of the site’s UK-based users access the site outside of school hours. This means that we should assume that learners accessing the site are doing so without planned teacher support. Even within schools, mathematics enrichment resources are often used when teachers are unable to fulfil the need themselves. Our users are individuals rather than groups or classes and so we are not particularly interested in IMS Learning Design (though we *are* interested in relatively unstructured online learning communities).

### ***Why is sequencing potentially important to NRICH?***

For individual learners, sequencing is important because it provides some of the context that would otherwise be provided by a teacher.

If a cluster of resources are sequenced with (in IMS terminology) ‘Flow Control Mode’, then the content developer is able to assume that the learner has completed earlier resources before the later ones are reached. Without sequencing, our learners and readers may (and regularly do) arrive at NRICH problems directly from a search engine hit list, giving us no chance to explain why we believe them to be worthwhile mathematical problems to tackle.

Early in the project, we also believed that IMS Simple Sequencing would help us build adaptive resources that could react to the learner’s performance in some way. During the course of building the demonstrator, we learnt that although this is in principle possible, the kinds of adaptation that we like to offer in NRICH stretch the standard too far. There are better ways of creating ‘intelligent’ resources. I’ll come back to this later.

(In case the suspense is too much at this point, I’ll reveal that we were forced to fall back on the capabilities of Macromedia Flash for many necessary features. Interestingly, this did not compromise the standards conformance of our resources, whereas attempting to use IMS standards themselves to implement these same features would have done so.)

### ***SCORM 2004 and Resource Reusability***

NRICH has a very wide audience which extends well beyond the university campus. We cannot predict which Learning Management Systems will be used to store and play any

IMS Content Packages that we produce. Most schools do not have or aspire to a Learning Management System, though there are a few notable exceptions where local authorities or grids for learning are encouraging their adoption.

Planning a package format for the future is not easy in this situation. Our best guess would be that Blackboard and SCORM 2004 formats will between them cover most possibilities. If we can further augment this by making packages that work standalone or by making use of a distributable client-side player, then we should have some measure of future proofing.

The issue here is that it is not enough to adopt IMS Content Packaging and IMS Simple Sequencing as these alone do not define the package format well enough to ensure reusability. These two standards do not define a standard API that can be used to communicate between a resource and the LMS, so they do not define a *content standard*. To do this – and to include a sequencing component – we must produce resources conforming to the SCORM 2004 profile.

These considerations determined that it would be necessary to produce two further adapter components – a SCORM 2004 CMI service, and a SCORM 2004 Player application – in order to build a reusable interface between NRICH packages and the ISIS Simple Sequencing Service. I suspect that many content developers would be forced to make similar choices if planning to create reusable content that communicates with a sequencing service.

## ***Methodology***

We wanted the exercise to be pedagogically driven, so we involved teachers early in the design cycle. One of the first tasks was to explain to them the new capabilities that sequencing could bring to a resource package. In the context of mathematics enrichment, the things that captured their imagination were:-

- Games based learning to motivate the individual learner.
- The idea of targeting a topic, orbiting it in an explorative manner, and then shooting off to some related but new topic. (We implemented this idea quite literally in the demonstrator.)
- The ability to control the learner's navigation. We were sometimes surprised at how much control the teachers wanted. ("I don't want them to leave this screen until they've done this"). At other times the teachers wanted there to be more freedom of choice than could easily be accommodated.
- The ability to reveal established results in a controlled manner, so allowing us to present them initially as conjectures. The student could then be engaged in an exercise of proving the conjecture or finding counter examples.

Things that were greeted with less enthusiasm were:

- The idea of preventing access to previously visited resources;
- Multiple choice assessments;
- The formalities of authoring a package;
- The effort and degree of detailed planning required;
- New technical skills – e.g. learning how to use a package editor;

- The complex nature of the development.

Once the idea of a sequenced activity was understood, the teachers were quick to come up with some candidate possibilities. We selected a very simple idea which had been used successfully in the classroom. It was clear that there was a wealth of prompting questions to hand that could be used to provide hints and to provoke responses from the user and hopefully be used to adjust navigation choices. This idea – a graph of numbers in the form of a letter of the alphabet, where the sum of the numbers in each line must be the same – was further simplified to an activity concerning the single letter V.

Further discussions added in the metaphor of an explorative space flight. This became quite valuable in simplifying the range of navigational possibilities to something that was tractable within the time limits of the project.

The educational content was then storyboarded in PowerPoint. An attempt to teach the teachers how to use a SCORM 2004 sequencing editor (InSite from Mississippi State University – think of it as a simplified Reload with flow charted activities) met with failure. The teachers wrote an informal description of the sequencing design using Word.

The moral of the story is that it is quite difficult to share the work load of producing the formal content descriptions (ultimately the creation of the IMS manifests) with the teachers.

Simultaneously, one of us commenced a second package based on a pre-existing activity on the NRIC site. The aim of this trail was to develop an introduction to group theory. It was not completed during the timescale of the project as there was insufficient time to design the sequencing and test it.

## ***Documentation***

Some things were clear from the outset. It would be unreasonable to expect the *end users* to read the available documentation as it was completely unsuitable for them. Remember that here I am talking specifically about documentation needed to build a SCORM 2004 package that includes Simple Sequencing; *not* the documentation for the ISIS project. The latter is rightly aimed at programmers rather than end users.

Authoritative documentation on SCORM 2004 is provided in the three ADL SCORM books and a number of appendices. Little else of value is available. There is some documentation for the CETIS Reload Editor, but this has not to my knowledge been extended to encompass the Simple Sequencing branch supported by CMU. Since InSite proved to be too much, Reload would have proved to be even less acceptable to the teachers.

The SCORM books are designed to assist implementers of SCORM conformant learning management systems. They are not readily accessible to content developers. These are technical manuals that have no place at the educational chalk face. As the main content

developer I found that I was still suffering from quite a few misconceptions about how the standards worked a few months into the project despite having studied these manuals.

### ***Limitations of the Evaluation***

There is a big gulf between the practical IT experience of teachers and that needed to create a packaged and sequenced resource. Currently, no free or reasonably priced authoring tools are available to bridge this gulf. Candidate teacher friendly tools such as Lersus and SCOBUILDER (Westcliff) were investigated, but these omit sequencing. MSU InSite is a promising possibility but is not yet SCORM 2004 conformant. Apart from some annoying user interface glitches, Reload works reasonably well, but falls a long way short of being usable by teachers.

Due to this gulf of understanding, our evaluation was limited in that it was not possible to carry out the planned questionnaire on the usability of the system or on its documentation. The content development ultimately fell entirely on me. The teachers helped in guiding the end result, but were not involved in creating it. They had no direct user contact with ISIS, with the Icodeon sequencing engine, with the IMS Simple Sequencing standard, with Content Packaging, or with SCORM 2004.

### ***The Evaluation***

As I'm really the only user here, I'll just have to give myself a little interview...

*Do you see a future for the ISIS deliverables and the Icodeon products in NRICH?*

Yes - but not in the way we originally intended. I'm actually quite optimistic about these products now that I have a good idea of their capabilities. The SCORM 2004 Player application created by Icodeon for this demonstrator is neat. We pushed the products too far with the demonstrator – by stepping back and simplifying I think there are some solutions that will really help us.

*OK – could this apply to other institutions?*

I believe the key to using Simple Sequencing successfully is to identify a subset of the standard that applies to your case, and then design some user-friendly content packaging tools that exploit just those features. Any institution that has a bank of learning resources or assessments could adopt this technique to organise them.

*So what subset might work for NRICH?*

In Simple Sequencing, each cluster of activities has a control mode. There you can set a number of booleans which determine whether the user is allowed to choose child activities or is forced to run through them in order and whether it's OK to go back. At leaf activity level, we might also include some of the precondition rules such as 'Hide from choice' which proved useful in the demonstrator.

*How would this work?*

A user wishing to create a package will browse the NRICH site and pick problems that are to be included. This is just like a web shopping basket application. When the user is finished (cf. proceed to checkout), they will preview their package,

upload additional materials to it, and adjust the package menu. At this point we can add some check boxes to set the Simple Sequencing control mode booleans. The user then downloads the package for use standalone or within a SCORM2004 LMS.

*What would be the user benefits?*

Primarily it's the fact that the ability to create a sequence of resources gives you the ability to establish a learning context. Notes and hints and assessments are only appropriate when you know that the learner has completed some necessary prerequisites.

*How would users play the downloaded packages?*

The Icodeon web application created for this project is one potential player. We have also tested the Knowledgeworks LMS from techniques.org. I'm sure more sequencing-capable SCORM 2004 systems will arrive shortly. Moodle and Dokeos are two open source systems that are moving in the right direction though neither of them have sequencing modules yet.

*What about teachers/students with no LMS?*

We'll create a default home page within the package so it will only be necessary to unzip and point a browser at this. The player provided with InSite suggests that a simplified subset of Simple Sequencing can be implemented client-side entirely in javascript. I think that will be enough for our purposes.

*Isn't this approach quite limiting?*

Yes, but to do much more you need the individual resources themselves to communicate with the server – and that's where things start getting complicated. Of course, if you are using some tightly controlled question format such as QTI, it may be possible to automate package generation further. NRICH resources do not lend themselves to the QTI approach however, and we would find ourselves generating custom code for each problem.

*Was it easy to communicate to the LMS?*

Javascript calls are easy enough to implement once you know what you have to do. The way objectives are handled by the standards is particularly problematic in this respect. Javascript communication itself is problematic when using other plug-in technologies (Flash in our case) since it is so browser dependent. It's a shame that there is no modern XML channel standardised for SCO to LMS communications.

*Could you not have used the ISIS Web Service directly from Flash?*

Yes we could have done this, but then our resources would no longer conform to any standard. They would be unplayable in a generic SCORM 2004 LMS.

*So how did you implement Flash to LMS communications?*

We used the escorte4as library from techniques.org. I'd recommend this route as it proved to be a reliable solution. There are a large number of pitfalls in store for anyone attempting to do this from scratch. For example, Flash provides special commands – FSCOMMANDS – for javascript calls, but these expose a Mozilla Firefox bug when used in combination with AJAX calls such as XMLHttpRequest.

*Did you find the Simple Sequencing standard pedagogically neutral?*

No. It's weighted to a 'teach then assess' pedagogy which can be unhelpful for individual learners working in an investigative manner. A couple of examples of will suffice:

1. If there is a retry limit on a resource then this is absolute. The student can never return to the resource even if the whole cluster is started afresh. In our demonstrator, we wanted a retry limit on the timed challenge so users would not be locked into that screen if they failed. However, once the retries had been used up, the user was unable to return to that cluster later and have another go. This approach to retries only makes sense when you want to use them to capture a failed attempt permanently in an assessment. We almost never want to do this.
2. Progress data written to the CMI data store is effectively write-only. The content developer has no control over how that data will be used or formatted by the LMS, and has no control over who can access it. This means that it is impossible to use the CMI data store to persist progress data that the student may find helpful in later SCOs. In our demonstrator, previous solutions are available in later SCOs – but these had to be passed through Flash's cookie-like SharedObject store.

*If you created this demonstrator again what would you do differently?*

I would do all the complex sequencing in Flash. The demonstrator was created from scratch, so we had the luxury of using a rich authoring tool such as Flash to create it. It would be faster and easier to construct the menu system in Flash. In other words I would have made the whole demonstrator one SCO.

*What problems slowed you down?*

The development cycle time lengthened unacceptably as soon as it became necessary to test the resource on the server. If the sequencing were all in Flash, then we would have avoided the cost of saving, repackaging, uploading, and clearing browser caches which we incurred in every cycle.

*So the granularity of the SCOs is not optimal in the demonstrator?*

Correct. We wanted to create an immersive games-based environment, and wanted to evaluate whether the sequencing service would help do this. Although we achieved the goal, we would certainly have got there much faster if the whole demonstrator was one SCO. My conclusion is that the sequencing service is not really suitable for games-based environments. However, this exercise has yielded an excellent SCORM 2004 Player application and an implementation of a CMI service that will be useful in other contexts.

### ***What about assessment and QTI?***

Mathematics enrichment does not sit easily with QTI. Take the time to look at these two simple examples and I think you will see the point. Try *Domino Numbers* at [http://nrich.maths.org/public/viewer.php?obj\\_id=2282](http://nrich.maths.org/public/viewer.php?obj_id=2282) and *More Number Pyramids* at [http://nrich.maths.org/public/viewer.php?obj\\_id=2728](http://nrich.maths.org/public/viewer.php?obj_id=2728). In both cases there are indeed a number of simple questions with definite answers that could be represented in the QTI

framework. To do so would miss the point of these questions entirely since here the learner is really being encouraged to assess themselves, to check their own thinking, and to see the generalities behind the specific examples.