Institution: The University of Huddersfield

Unit of Assessment: 11 Computing Science and Informatics

Title of case study: Development of a Next-Generation Student Response System for Academia and Industry

1. Summary

Professor Zhongyu (Joan) Lu's research contributed significantly to the development of a next-generation student response system (SRS) that is fully integrated with web services, Smartphones, multimedia and other ubiquitous technologies. By incorporating the use of widely available online equipment, the system has made SRS more affordable, easier to employ and applicable in a range of settings far more diverse than the traditional classroom scenario. It is now used in Europe and the US by both academia and industry and has served as the basis for a number of dedicated prototypes. Its success has also led to additional major funding streams for further research.

2. Underpinning research

The potential benefits of using technically advanced response systems in educational settings have earned growing attention over the past two decades. Formative research in the early 1990s suggested such technology, often known as a Student Response System (SRS), could improve interactivity by a factor of 10 times compared to a "traditional" classroom environment. It is now widely accepted that employing an SRS, so allowing students to participate in the processing of questions and the formulation of answers, can greatly enhance the learning experience.

Professor Lu's research in the XML, Database and Information Retrieval has been at the forefront of a series of major projects in this field. She has published 5 research books in the subject area. Lu's 2005 overview of XML, the markup language for encoding documents in a machine-readable and human-readable format optimised for the internet, offered one of the first comprehensive assessments of its impact on knowledge-management and content-management systems and the resulting challenges in information and knowledge engineering [1, 2]. Her research initiative has been awarded an EU grant in Edumecca (2008-2010) to develop a next generation's SRS. Recently one of her published research books [3] "*Learning with Mobile Technologies, Handheld Devices and Smart Phones: Innovative Methods*" reported that her knowledge and activities are further expanded into a real world application, learning in the mobile age, a new trend in the pedagogical community.

In 2008 the European Commission's Lifelong Learning Programme sponsored Edumecca, a pilot project to investigate the potential of "new educational models that encourage creative transfer of competence and acquaintance in lifelong learning". As a key partner in the initiative, Professor Lu played a leading role in developing methods of successfully integrating SRS with advanced web services, Smartphones, multimedia and other ubiquitous technologies to create the basis for a next-generation system [4, 5].

A traditional SRS includes a receiver for instructors, a collection of keypads (known as transmitters or "clickers") for students and a dedicated software component. It uses infrared or radio frequencies to facilitate communication and might often be limited to multiple-choice-type or yes-or-no/true-or-false-style questions. Despite the shortcomings of such a set-up, costs can be prohibitive, deterring many institutions from adopting such technology. A fundamental aim of the Edumecca project was to advance the concept to a more accessible and cost-effective level.

The resulting SRS offered a platform-independent, internet-linked technology able to function anywhere and at any time. Unlike earlier systems, which were essentially self-contained and thus confined to the classroom, the web-based Edumecca SRS is constrained neither to a single location nor to a single subject area, allowing it to be used in a range of scenarios and by a variety of learning groups. It enables teachers to initiate questions, students to respond using their own mobile devices – phones, laptops or tablet computers – and data to be collected and automatically stored for future retrieval [5, 6]. The system's lack of restrictions means it can be employed in activity-based, opinion-based and problem-based educational settings and irrespective of the size, age or knowledge background of the learning group, shown in the Demonstration and Best Practice Sessions DEM17/DEM32, EDUCA, 2009, the world largest e-learning conference in

Berlin. http://www.jfernandoferreira.com/mgse/oeb/sessions/demonstrations.html.

The Edumecca SRS was further refined during subsequent research funded by two additional EU grants. The first, DO-IT, which began from 2010, internationalised the technology, extending the system's use to speakers of Hungarian and Romanian. The second, DONE-IT, which began from 2011, focused on a series of technical advances, including assessment in automatic marking/grading, security encryption and authorisation, interactive monitoring and optimisation for popular mobile operating systems such as iOS, Android, Windows and Symbian [6].

3. References to the research

Publications:

1. Lu, Z (2005): A survey of XML Applications on Scientific Technology, *International Journal of Software Engineering and Knowledge Engineering*, Vol. 1, 1-33, 2005 Official URL: http://dx.doi.org/10.1142/S0218194005001902; DOI: 10.1142/S0218194005001902; http://eprints.hud.ac.uk/245/
2. Lizhen Wang, Lihua Zhou, Joan Lu, Jim Yip, An order-clique-based approach for mining maximal co-locations, Original Research Article, *Information Sciences*, *Volume 179, Issue 19*, *9 September 2009*, *Pages 3370-3382.*
3. Lu, Joan (2012): *Learning with Mobile Technologies, Handheld Devices and Smart Phones: Innovative Methods,* IGI Global, Hershey, PA, USA, ISBN 9781466609365 http://eprints.hud.ac.uk/15241/
4. Lu, J, Meng, Z, Lu, G, and Stav, J (2010): A New Approach in Improving Operational Efficiency of Wireless Response System, *10th IEEE International Conference on Computer and Information Technology*, 2676-2693, ISSN 9781424475476 http://eprints.hud.ac.uk/10656/
5. Lu, Z. and Rahman, U., Semantic Search Technology for Information Retrieval on the Web, International Journal of Agent Oriented Software Engineering, vol. 1, No. 2, page 225-243, June, 2007, DOI: 10.1504/IJAOSE.2007.014408,
6. Meng, Zhaozong and Lu, Joan (2011) *Opportunities of Interactive Learning Systems with Evolutions in Mobile Devices: A Case Study.* In: Proceedings of the 2011 International Conference on Internet Computing ICOMP 2011. CSREA Press, pp. 238-244. ISBN 1601321864 http://eprints.hud.ac.uk/17182/

Evidence of Quality of Publications:

For 1.,2., 5., and 6., all outlets are ranked as "B" by the Aus. ERA 2010. 1. was one of the Top 6 accessed articles announced by Notable Titles in Software Engineering 2006, see http://www.worldscientific.com/action/doSearch?searchType=normal&publication=&searchText=ZHongyu+Lu+top+6+access&publicationFilterSearch=all&. *Information Sciences* had an impact factor of 3.291 in 2009, and paper 2. has 34 citations according to Google. 3. is a published book in the area of learning in the mobile age and addressed the latest mobile learning technologies and research discussions.

Grants:

European Commission Lifelong Learning Programme: Edumecca, project no. 143545-LLP-NO-KA3-KA3MP, January 2008 to December 2010 – €495,125 (€110,739 awarded to University of Huddersfield, PI at Huddersfield: Joan Lu)

European Commission Lifelong Learning Programme: DO-IT, project no. 2009-1-NO1-LEO05-01046, January 2010 to December 2011 – €300,000 (€73,271 awarded to University of Huddersfield, PI at Huddersfield: Joan Lu)

European Commission Lifelong Learning Programme: DONE-IT, project no. 511485-LLP-1-2010-NO-KA3-KA3MP, January 2011 to December 2012 – €686,652 (€116,478 awarded to University of Huddersfield, PI at Huddersfield: Joan Lu)

4. Details of the impact

Research led by Professor Lu has played a critical role in informing the creation of the Edumecca SRS, an innovative solution to the problems of previous student response systems. By incorporating the use of widely available equipment – specifically, the internet and mobile devices – SRS has been made more affordable, easier to employ and applicable to a range of scenarios far more diverse than the traditional classroom setting. It is now used in Europe and the US – not

just by academia but also by industry – and its success has led to additional major funding streams for further research.

Between January 2009 and December 2010 the Edumecca project was presented at around 60 events across Europe, including December 2009's Online EDUCA, held in Berlin, which attracted more than 2,000 attendees and was described as the world's largest conference on technology-supported learning and training. Almost a hundred institutions worldwide, including schools, universities and companies, were also given access to the SRS for testing during this period. These dissemination efforts, coupled with the advances and advantages they served to highlight, have since been reflected in the geographical and disciplinary spread of the system's use.

Internationally, the Edumecca SRS has been employed by institutions including NTNU, Trondheim, Norway; the Centre for Flexible Learning, Söderhamn, Sweden; Onderwijscentrum Vrije Universiteit Amsterdam and the University of Amsterdam, Netherlands; Hogeschool-Universiteit Brussel, Brussels, Belgium; the University of Zagreb, Croatia; Petru Maior University, Târgu Mure, Romania [a]; and Kennesaw State University, Georgia, US [b]. The range of subjects covered includes physics, electrical engineering, sport and nutrition, computing, mathematics, history, languages and religion – illustrating the Edumecca SRS's suitability for both problem-based learning (in which a question might have only one correct answer) and opinion-based learning (in which several answers might be acceptable) [c]. Feedback from users to Professor Lu has demonstrated the system's ability to offer the acknowledged benefits of earlier forms of SRS (e.g. increased participation, enhanced capacity to gauge students' comprehension) while significantly widening the technology's applicability and reducing associated costs (the average commercial SRS retails at around £1,000 for a 30-student classroom; the Edumecca SRS significantly reduces this figure by precluding the need for "clickers") [d].

The system's effectiveness in small-group teaching has also been highlighted, with the University of Buckingham publishing the results of a pilot exercise in which all but one of the students who took part agreed that the Edumecca SRS "enhances the learning experience". The findings, published in 2011 in *Italics*, the e-journal of the Higher Education Academy, concluded: "The use of a SRS has had a positive effect on student learning and students' experience in small-group teaching... [It] increases participation, helps students understand the lecture and indicates where further effort is required" [e].

The system's effectiveness in large-group has also been addressed, with Petru Maior University of Tirgu Mures in Romania for a group of 260 students. From Professor Moldovan: "Students enjoyed this new technology enhanced learning instant feedback, participation, motivation because the mobile evaluation deploys advanced wireless response technologies." "This new technology brings economic benefits to the training, as the system can use the low cost devices like iPod touch in comparison with commercial product Click." Following a further innovative approach, SRS has been internationalized into other EU languages: Romania and Hungarian. Professor Moldovan further stated that through Professor Lu's research, the mobile learning methodology is not just used by English speak users but also by native Romania speak users [a].

The experience that related to the SRS is also stated by Dr Powell in Knennsaw State University, USA, "The SRS system did open our eyes to the world beyond clickers and to the deficiencies in online systems like "poll everyone", it showed us what was possible, and we really appreciate that. The technology used in SRS is advanced and brings economic benefits to the users, as the system can use the low cost devices like iPod touch or users' own devices. The system also saves data for faculty, allowing them to measure student improvement in the polling activities over course sections or time." "This tool is of great benefit for faculty wanting to show improvement in teaching strategies or wanting to test the effectiveness of different strategies in multiple sections, without resorting to exams. Your innovative approach in mobile learning system sheds light on the new trend of pedagogical circle, i.e. learning in mobile age. Fortunately for us, the impact of your work stretches beyond England and the European continent to the United States, where we are very lucky to be able to benefit" (b).

Adoption of the Edumecca SRS has also helped a number of institutions secure major funding. In 2011 the Centre for Flexible Learning was awarded a €300,000 EU grant to help transfer and disseminate the technology, while Sør-Trøndelag University College, Trondheim, won similar funding, worth around €3m, in 2012 [f]. A great potential of SRS commercialization has been proposed in the EduMecca exploitation report [g].

The flexibility of the system, particularly its capacity to facilitate "distance learning", has allowed its use to be extended to industrial, laboratory and other settings. In several countries it has formed a key element of the training required for the Welder Certificate qualification. The Hungarian Association of Welding Technology and Material Testing made the system available to 90 companies and more than a thousand people in 2010. Norwegian firm QM Soft has used it in eight modules of its training course, and it has also helped train welders in Sweden, Slovakia and Slovenia. Studium Ltd, the company subcontracted by the Hungarian Association of Welding Technology and Material Testing to carry out training, has reported the Edumecca SRS's "positive impact on student learning and experiences" [h].

In 2011, in response to a request from Leeds University's bioscience department, Professor Lu used the SRS technology as the basis for Mobile Lab Mate (MLM), a mobile application allowing the automatic submission, storage, retrieval and visualisation of data generated in experiments. The system reduces users' workload by obviating the need for paper-based logbooks [i]. Efforts to commercialise MLM for wider use are now under way. At the request of Helen Ribchester, a Senior Lecturer at the University of Huddersfield's School of Human and Health Sciences, the prototype of a similar system was also produced for occupational therapists. The work has been presented in the two large International conferences on Digital Society in France and Software Engineering Research and Practice, USA 2013.

The technology has also been used for industrial applications, including the development of a user interface controller for ML Shaw Fabrications Ltd's patented Intelligent Kitchen Ventilation (IKV) system. They mentioned in their letter "…with your help and involvement we were able to move a lot quicker than we anticipate and we are now in production of selling the IKV system to schools and colleges.". The Manchester-based company paid more than £600 per set for its previous interface, whereas the Huddersfield-designed successor costs only £110 per set – a saving of around 75 per cent for the firm [j].

5. Sources to corroborate the impact

a. Supporting statement from the Vice Rector, Petru Maior University of Tirgu Mures, Romania (available on request).
b. Supporting statement from the Director of Distance Education, College of Humanities an Sciences, Kenneshaw State University (available on request).
c. Evaluation report from the University of Derby (available on request).
d. Sample agreement with overseas university (available on request).
e. Sellahewa, H (2011): Using an Online Student Response System in Small Group Teaching: A Pilot Study, *Italics*, e-Journal, vol. 10 (3), 38-42 http://www.ics.heacademy.ac.uk/italics/vol10iss3.htm (see "Papers", fourth link).
f. The announcement of the award, http://histproject.no/node/120; http://www.adam-europe.eu/adam/project/view.htm?prj=8669
g. Report of the Edumecca consortium (available on request).
h. Supporting statement from Studium Ltd, subcontracted by Hungarian Association of Welding Technology and Material Testing to provide SRS training (available on request).
i. Feedback from the School of Biosciences, Leeds University (available on request).
j. Supporting statement from the Technical Director, ML Shaw Fabrications Ltd (available on request).