

Towards a Centre for Constructivist Computing

In this project, we shall establish a collaboration between Computer Science (CS) and the Institute of Education (IoE) that will refine, deploy, evaluate and disseminate a new kind of educational technology based on principles and tools developed in CS. We intend to seek funding from EPSRC-ESRC and EU FP7 technology-enhanced learning (TEL) initiatives with the long-term goal of creating a centre to support a new vision for computing that is well-aligned to a constructivist outlook on learning. Such a vision is strategically important in relation to the future of computing as an academic discipline, the decline in interest in computer science in higher education and the current limited conception of ICT in schools.

Brief background and context

Empirical Modelling (EM) is a body of principles and tools that has been developed in Computer Science. It offers a distinctive innovative perspective on computing based on an alternative conceptual framework in which the emphasis is on software development as a *constructivist* activity, whereby gaining understanding of the domain and model building proceed in parallel. Viewing computing as constructivist in spirit is not a new idea (cf. the tradition of constructionism based on LOGO-like languages, and Floridi's *Philosophy of Information*). However, in our view, the traditional conception of computing - where the primary interpretation of a computer program is formal - is in tension with a constructivist outlook. In EM - in contrast - the meaning of a computer-based artefact, being first and foremost experientially mediated, can be (where this is appropriate! - as it is in many authentic learning contexts) ambiguous, subjective and negotiable.

A constructivist stance is particularly relevant for educational applications. Educational technology has been a central focus in about 25% of the 60 or so EM research papers published since we first recognised the significance of this connection for EM. In 2005, we were invited to present a five day workshop for graduate students on this theme at the IEEE International Conference on Advanced Learning Technologies in Taiwan, and a suite of posters and demonstrations at an EU TEL-funded Kaleidoscope Network of Excellence Show Case Event in Germany. Working together with many computer science students (both postgraduate and undergraduate), we have exploited EM for educational applications in more than thirty projects, in a special-purpose environment for teaching database query languages used by several hundred students, and as a key ingredient of an advanced undergraduate module (CS405: "Introduction to EM"). We have also submitted research proposals relating to EM as a constructivist vehicle to the EPSRC Basic Technology Research Scheme (2003 - £1.5 million), to the EU under the FP6 Technology Enhanced Learning initiative (2005 - approximately 3 million euros) and to the EPSRC/ESRC TLRP initiative (2007 - approximately £500K). These research bids have spawned significant ongoing collaborations leading in particular to joint publications with Dr Willard McCarty - a world authority on Humanities Computing, and with Prof Erkki Sutinen's Educational Technology research group at Joensuu, Finland.

In preparing collaborative bids with external partners, the EM group is handicapped by its unconventional perspective on computing. This makes it harder to gain the shared understanding that is essential for an effective bid. In preparing the proposals cited above, the EM group has had to take an undesirably dominant role, and much time has had to be invested in winning the confidence of potential collaborators. As a result of our most recent proposals, we have attracted enthusiastic interest from several researchers in the Warwick IoE, and from a consortium of leading European educational researchers in Finland, Denmark, the Netherlands and the London IoE. We intend to capitalise on this in preparing further submissions to the ESRC/EPSRC TLRP and EU FP7 programmes. We appreciate the need however both to enhance the quality of our submissions by building on deeper and more sustained preparatory collaborations, and to further raise the external profile of EM in this application area. EM research has a wide remit, and the two permanent academic staff members of the EM group are heavily committed in meeting the demands of teaching an EM module, supervising research and project students, and maintaining key tools and models. Viable external engagement with the broad international TEL community requires the involvement of a well-qualified person with a sufficiently mature grasp of EM in its relation to education. A postdoctoral assistant with a PhD in EM for education is the obvious candidate. One such PhD student, Roe, graduated in 2003 and subsequently (vicariously!) applied his EM expertise in the CeNTRE with notable success. A second, Harfield - a former Warwick Postgraduate Research Fellow, will complete his PhD later this year.

Aims and Objectives

The overall aim to which our proposal contributes is to capitalise on the unusual qualities of EM as a vehicle for "constructivist computing". Our long-term goal is to establish a centre devoted to this theme at Warwick that can support educational researchers nationally across many sectors. Such a centre reflects a new vision of

computing, broader than Computer Science as currently generally conceived and established, that is better aligned with local initiatives such as the CeNTRE and the Digital Laboratory. The present project will be primarily aimed at securing funding under the TLRP scheme, whilst continuing to consolidate existing relationships with European allies with a view to submitting a revised EU application at the next opportunity. To enhance the quality of research proposals and raise the profile of EM in educational applications, we must address the following objectives:, which promise strategic benefits both to education and computer science:

- equipping EM tools for use by educational researchers, teachers and learners;
- exposing EM experts to specialist educational knowledge and practice;
- transferring practical knowledge of EM principles and tools to colleagues in education, potentially to schools, and to external institutions with whom we have links;
- acquainting educationalists with EM thinking and its implications, so that they can make better informed criticisms and suggestions;
- identifying and responding to opportunities for collaboration and funding in the technology enhanced learning field.

Methodology

EM principles and tools have already found significant application in teaching computer science. Much wider aspirations are reflected in EM publications, and in miscellaneous occasional activities including school visits, workshops for teachers, and seminars given at the IoE. To date, with only casual collaboration with educational specialists, it has proved difficult (e.g.) to fully appreciate the wider connotations and political implications of key words (such as 'constructivism' or 'e-learning'), to know what might work in the classroom, to recognise what pupils are capable of and find engaging, to understand the true difficulties of evaluating learning and assessing cognitive capacities, and to become familiar with the strengths and weaknesses of existing electronic resources as they apply to different subjects and levels. For their part, educationalists are best qualified to advise only if they can appreciate the potential of EM tools when appropriately and skillfully used, and can be open to a conception of computing broader than "computational thinking" as characterised by dedicated planning, a commitment to abstracting from situations, and a foundation in formal symbolic systems.

To address these communication concerns, we shall employ Harfield in the role of a postdoctoral research assistant to facilitate interdisciplinary communication centred on a series of joint seminars to be complemented by mini-workshops on key topics and individual consultations with educational specialists from the CeNTRE and TEL specialists in CS. Harfield has a strong commitment to research on technology enhanced learning and is responsible for some of the key EM tool developments behind much of our recent work on education; he has also been fully engaged in initiatives for teaching and evaluating EM. Harfield will have a base in both computer science and education, liaise with researchers and research students in the CeNTRE, and participate in seminars such as those to be given by Engestrom and Kumpulainen in the IoE in 2007-8. He will also set-up and maintain a project website that is linked into both the EM website and that of the CeNTRE.

In the initial phase of the project, mini-workshops will be held to review our previous research proposals, and to give a high-level introduction to EM for participants from Education. Six core seminars will be organised thematically in pairs, each pair being devoted to a particular role: teacher, learner and educational researcher. (This echoes key features of our EU FP6 and ESRC TRLP proposals.) The first seminar of each pair will adopt an educational perspective. It will identify possible role-related topics suitable for mini-project collaborations and refine relevant broad goals for EM tool development that (as detailed in the project timetable) have already been identified. Feedback will be given from an EM perspective at the second seminar 3-4 weeks later. The seminars and associated targeted consultations, which may involve research students as well as staff associated with the CeNTRE, will suggest experimental mini-projects to be trialled - if this proves feasible and appropriate - in the final phase of the project. The CS405 module, which runs in the second term, will also provide opportunities for trialling new tool developments in demonstrations in lectures, in practical laboratories, and subsequently in the evaluation of project work. There will also be potential for aligning EM projects to educational themes both in connection with CS405 coursework and MSc projects. Harfield will provide practical support and act as a technical consultant for these activities.

To promote external visibility for our research, and maximise the chances of successful applications, we shall co-opt external advisors to include Dave Pratt (IoE, London), Liz Burd (CS, Durham), Tom Boyle (LTRI, London Met), Dave Riley (ICL) and our potential international collaborators, all of whom have interacted with us in the past. Richard Noss (EPSRC-ESRC TRLP Associate Director for TEL) has recently shown a strong

interest in our research on EM for education, and encouraged us to make a further bid. Noss has commissioned us to give a seminar at the London Knowledge Laboratory in December. We shall arrange a preliminary meeting with our advisory board at the start of the project, maintain regular electronic contact, and invite them to our final workshop that will report on the project in July 2008. We shall prepare submissions for the ICALT 2008 conference in Santander, Spain in July 2008 and - after the end of the project - for the BERA 2008 conference to be held in Edinburgh in September 2008. We shall consult Alan Brown in the IER, currently on the TLRP evaluation panel, in preparing our TLRP proposal for submission to commence in May 2008.

Brief timetable

Month	Collaborative and liaison activity	Research and Development
Nov	Introductory mini-workshop on project agenda	Preliminary tool requirements
Dec	Seminar at London Knowledge Lab (11/12/07)	Seminar preparation
	Discussion(s) with advisory board members	
	Preliminary EM mini-workshop	Prepare CS405 pilot activities
	Attend EU FP7 TEL Information Day (18/12/07)	
Jan	Joint seminar 1: Learner educational perspective	<i>Web enabling, interface extension</i>
Feb	Joint seminar 2: EM for Learner perspective	<i>ICALT 2008 submission</i>
	Joint seminar 1: Teacher educational perspective	<i>Presentation environment, assessment</i>
Mar	Joint seminar 2: EM for Teacher perspective	
	Joint seminar 1: Researcher educational perspective	<i>Monitoring techniques, learner construals</i>
Apr	Joint seminar 2: EM for Researcher perspective	Initiate EM-education MSc projects
May	Initiate proposal preparation	Pilot CS405 project evaluation
	Initiate experimental school-based projects complementary tool refinement
Jun	Proposal preparation	Consultancy for <i>school projects</i>
	Final Report preparation	... ongoing in parallel with ...
Jul	ICALT 2008	Consultancy for <i>MSc projects</i>
	Final project workshop with advisory board	

Project management The bulk of the practical work on the project will be carried out by Harfield. Beynon and Hammond will take overall responsibility for coordinating the project, and be the primary points of contact for activities that are centred on EM and educational issues respectively.

Outcomes The practical products of the project (see the italicised entries in the timetable above) will include radical improvements to the existing EM tools, such as web enabling, improved interfaces, new techniques for presentation and assessment, and innovative means of monitoring and capturing learner construals, together with conference papers, projects and associated know-how. These will all contribute to greater visibility and appreciation of the potential for EM principles and tools amongst educational researchers and in schools. We shall make a revised bid to the TLRP programme. Should this fail, the project will equip Harfield to champion EM for education in other contexts - perhaps (e.g.) in a postdoctoral role in London IoE. There are potential implications for the future development of computer science and ICT in schools.

Brief justification of costs Funds will be required to support Harfield for November to July, to provide financial support for liaison with members of the advisory board (including the final workshop), and for briefing and conference attendance. Only the cost of Harfield's PDRA position is requested from the RDF.