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## Report on Survey of Technology-Enhanced Research (TER) in TEL projects

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### Introduction

All TEL projects are highly innovative in the ways that they exploit technology for teaching and learning. However, the purpose of this survey was to find out the extent to which TEL projects exploit technology for technologically enhancing *research* (e.g. methodological innovation, data collection etc).

The survey is one activity of the TEL programme's technology-enhanced research (TER) Thematic Strand. The purpose of the survey was to determine the range of research technologies that projects are using at various stages of the investigative cycle, including prototyping, data collection, data representation to participants, data analysis, results dissemination and data-archiving. A valuable outcome will be to make researchers aware of the TER activities of their colleagues on other projects so that projects facing similar challenges can share ideas and experiences. Another planned outcome to enable TEL to support projects' TER needs at programme level. The first support event will be a TER workshop in Warwick on February 25-26th. At the workshop there will be speakers and presentations on TER topics of relevance across projects and the workshop will provide a forum for projects to share TER ideas and experiences with each other.

A few words about the survey methodology....the survey questionnaire instrument was devised and placed online using the 'SurveyMonkey' service. The survey can be accessed from the TER Thematic Strand web page - <http://www.tlrp.org/tel/ter/>

Project members were invited to participate by email.

The main body of the survey questionnaire consists of 10 questions requiring open-ended responses of about one paragraph. Survey questions asked projects to indicate their use of technology for research in areas such as prototyping and software development, data acquisition, reuse and archiving, online surveys, psychometric testing, and the dissemination of results. A question on ethical considerations was also included, together with one which asked respondents to describe project 'critical incidents' ("....can you identify any specially significant event or activity..."). Participants were also provided with an opportunity to comment on any issue that they felt the survey hadn't covered.

### Results

Twenty-three responses were received overall. Between one and six people per project responded to the survey. In terms of respondents' roles, 13 were investigators and 10 were researchers.

The TER activities of each project are summarised below:

#### **Echoes 2 - Improving Children's Social Interaction through Exploratory Learning in a Multimodal Environment**

3 respondents: 2 Investigators (with backgrounds in Informatics, Design), 1 Researcher (Computer Science).

Echoes uses a variety of technologies including touch screens, gaze tracking, motion capture, web cams, sound input and output. Numerous different software packages are employed for different jobs – these include Flash, Super-Collider (music synthesis programming language), Java and C++, together with Internet Communication Engine (ICE) middleware for system integration. At an early stage of their work they used surveys, then moved onto workshops in schools, focus groups, and similar. The workshops were videoed for

analysis - this was a one-off analysis - they do not yet have plans to incorporate a 'reflection phase'. The project's consent form for design-partner participants provides for videos to be used for articles and presentations. All data is stored securely on an external backup drive. As well as traditional methods of disseminating results, they are making a video to show the children the background of the project. One respondent emphasised the importance to them of traditional methods in conjunction with tech-enhanced methods: "We followed a very pragmatic approach, whatever technology worked for what we needed was employed. It also pays off to be as simple and low-fi as possible in the beginning of design work (e.g. paper & pen to prototype touch-screen stuff). As a consequence, I believe it's key to let the learner be in the centre of the development, not the technology."

### **Ensemble - Semantic Technologies for the Enhancement of Case-Based Learning**

4 respondents: 3 Investigators (Education x2, Education/sociology), 1 Researcher (Education)  
[also one empty response from an Investigator in Education]

Again, much variety in technology use: Virtual research and semantic technologies are used in the Ensemble project plus recording of audio and video of participants, also screen capture. Virtual research refers to the use of networked repositories to share data, the use of a VRE and groupware/social media tools for project management and communication. Data is being analysed using qualitative annotation tools such as Atlas and video mark-up systems. Most data appears to be qualitative (interview recordings, videos and screen capture and research methods are conventional ones rather than exploratory, according to one of the investigators). There is a large emphasis on use of prototypes and how this translates to software development (and back again to the prototype). One investigator commented "How these two aspects [prototyping and software development] inter-relate is a key current issue and we are questioning some of the conventional process of HCI in this respect, seeing the process as more dialectical." The Ensemble team do not think that very "fine-grained" data is appropriate for studying how people learn from cases. Project data are being re-used for critical incident analysis and co-interpretation of learning. In terms of archiving and preservation of data for future re-use - this is a high priority - data are kept and semantically tagged with descriptive information. Results are disseminated mainly through web demonstrations, videos and publications. Ensemble aims to publish across a wide range of sources/media. The project has developed an ethics framework which other projects may also find useful. An investigator described a significant project event when it was realised that sometimes "we only see what we are looking for":

"The project team will have different answers to this question (about significant project events). A key moment for me was in observing the teaching of ancient ceramics in a museum setting when I realised that a key aspect of the knowledge being revealed was in the lecturer's use of her hands.. Archaeologists have talked to us a lot about teaching students to observe, but I suddenly realised that what they are being asked to 'see' is actually not there. It lies in the invisible - the missing vessel of which this is a fragment, the timber frame building that is now just a discoloration in the soil . . . There was one researcher and one research student present and we have discussed this several times (but I guess it has become my obsession!). I am currently trying to relate it to planning (what Lundgren - in talking about curriculum calls the gap between 'hope and happening') but in my case I am looking at educational architecture." There were also some reflective comments from two of the investigators, when asked about any further issues that might not have been covered by specific survey questions:

"The sense that the project is itself a research setting, therefore we are reviewing and developing our own use of technologies in our own practice, discourses and learning"

"The way ENSEMBLE is set up there are opportunities for using more innovative methods but for the moment I don't see this as a priority - it is more important to follow the logic of the project. This is especially important in a project that is wide ranging in content ('case-based learning') and has its focus on an emerging set of technologies (semantic tools). Just bringing these two thematic elements together is challenge enough!"

### **InterLife - Interoperability and Transition**

0 respondents:

### **LDSE - A Learning Design Support Environment (LDSE) for Teachers and Lecturers**

1 respondent: 1 Investigator (no background given), 0 Researchers  
[also one empty response from an Investigator with background in Computer Science]

Technologies used in research - in addition to desktops/laptops, LDSE is using iPhones and recording equipment for research. Prototyping/software development: A number of different softwares for different jobs: MS Office for several tasks, Flash/OmniGraffle for prototyping, Protege/Jess to record ontologies.

One respondent mentioned that these technologies "don't join up very well" - there was also a concern expressed that too much time will be spent on this. Mention was made of paper-based (printed) screen shots for users to write on. Data is being acquired by recording interviews and from online surveys. Most notes/reviews/analyses by researchers during research seem to be being done traditionally; one exception being that if a user is working through Powerpoint slides, their comments are logged in the notes section of that slide. Documents are shared between researchers through Google Docs, Google groups also used for research. The project is collecting qualitative and quantitative data. Critical Incident Analysis techniques are used during user workshops but to avoid disturbing users as they work, video recordings are replayed when the task is completed. Data are not archived - this is not seen as appropriate - data is related to current state of a design that is evolving during the project. Mostly traditional dissemination of results, papers, some design tools made available online. Other uses of technology are project-management related e.g. planning tools. There are future plans to adopt 'Synchronous video collaboration' - potentially suitable tools will have to be identified for this though. Significant project events: using OmniGraffle to simulate interface prototypes has allowed a lot of experimentation prior to implementation, although making a representative prototype of a working system is difficult and time-consuming. Other software use (Protege) has not been so efficient - a respondent speaks of 'trying to use' the software rather than it being helpful for them.

### **MiGen - Intelligent Support for Mathematical Generalisation**

4 respondents: 1 Investigator (Education), 3 Researchers (Computer Science x2, AI ed)

This project's emphasis is upon innovative software for traditional computers (for classroom settings). Video/audio recording and remote desktop connections are used to capture all student/computer interactions, alongside pen-and-paper prototyping. The project is acutely aware of the need to make best use of the hardware that schools already have in place rather than asking schools to purchase new technologies. Iterative prototyping is performed using traditional methods - paper-based prototypes at first, moving to code (mostly Java). Student feedback and student/computer interaction data are collected for feedback to students and teachers, also for further analysis at a later stage. The collected data forms an input to iterative design cycles. Some tools have been developed to capture data through remote desktop connections to the student's screen and were described briefly by the researcher respondent. These tools might be useful for use by other projects. Data granularity is at level of individual learners rather than survey-based at the moment although project may possibly use survey methods later. Quantitative (deriving statistics from the interaction data and performing data mining on log files of the system) and qualitative, assisted by tools like Transana (data management/analysis software - [www.transana.org](http://www.transana.org)) . Data are analysed from multiple perspectives and is formative - informing design of the next iteration of the projects maths pattern software. A 'stimulated recall' methodology is planned for the project's final year evaluations - this will entail showing users "automatically-generated videos of their interactions with the system so that they can reflect and annotate, aiding their understanding of their actions and potentially as a powerful incentive to fuel collaboration." Annotation by users is an innovative idea and there is potential for making the interaction data available 'somehow somewhere' for future researchers. Project results are published in papers, and via a web demo. Software is open source and available through a repository to anyone interested. One respondent here mentions using 'wink' for creating tutorials out of the results (<http://www.debugmode.com/wink/>).

Respondents mentioned that ethical issues arise when videoing participants, also in relation to participant anonymity and the mild deception involved when making participants think a computer is helping them when actually it is a hidden human (i.e. 'Wizard of Oz' method). One researcher mentioned issues concerning the logging of student data - again linked to anonymity and also to whether it should be made available and who should see the data. MiGen is very open to any help on exactly how to interpret the data available to 'read the participant's mind' and questioning whether their methods are adequate here. One respondent describes how its not just the TEL tools which could be re-used across different projects - many of the project admin-type tools (e.g. shared calendars, timelines) could themselves be re-used across different projects to save time setting them up for each project.

### **HAPTEL - Personalised learning with Haptics when Teaching with Online Media**

2 respondents: 0 Investigators, 2 Researchers (MRes on project, Learning Sciences)

[also one empty response from a Researcher in web search]

HAPTEL uses mannequin dentistry simulators with audio/video data collection (motion capture, tutor/learning conversations, head-movement tracker). Other data is also collected in log files from foot controls, dynamic screen capture, user/system interaction. Tutors provide assessment scores of students' performance during the learning process. Users also provide attitude scale ratings and undergo psychometric tests and online surveys. One researcher on HAPTEL has a keen interest in TER so is going to re-analyse the log data to see what else can be learnt, alongside other research they are doing around visual representations of their research and previous research which made large use of TER. It appears this researcher is making real efforts to persuade other members of the project team to collect from multiple sources of research data. Ethical issues are hindering data sharing in at least some areas of the project, though log files are being shared. Ethically the issue was raised of whether the students in the control group (or in the haptics-only group) are being hindered educationally relative to students in the experimental conditions. The project recently launched the hapTEL Virtual Dental Lab and had its first sessions with a whole Year 1 cohort of dentistry students. The hapTEL project is planning to acquire large data sets: quantitative (e.g. students' performance scores in course related activities, scores from the psychometric tests, logs of computer and haptic operations, etc.) and qualitative (e.g. video data, worksheets, observations on student-tutor interactions, screen capture, etc.). The project plans to integrate the various forms of data perhaps using INTERACT or bespoke project software. A researcher reported that the data will be integrated in different ways as the team have different methodological perspectives on analysing data subsets, for example the group in charge of analysing tutor-learner interaction data will be using a particular framework. One respondent stated that an interdisciplinary TER challenge for the project lies various project subgroups' analyses will inform other subgroups' analyses. One of the hapTEL doctoral students' PhD project is looking at formative feedback technologies and their effects on learning and tutor feedback.

#### **Personal Inquiry (PI) - Designing for Evidence-based Enquiry across Formal and Informal Settings of Learning**

4 respondents: 3 Investigators (Psychology, Learning sciences, Education), 1 Researcher (Educational tech)

A lot of different hardware being used on the PI project: sensors and data probes, GPS receivers, video, photos and audio. Much of the technology is for mobile use and is relatively inobtrusive: e.g. mini laptops rather than traditional size, lapel microphones rather than fixed microphones, wireless networks. Software to support this technology consists of a mixture of existing and custom-made software (mostly implemented in the Drupal web-based environment). Software design is iterative with participatory design involving students, teachers and domain experts through workshops. Pedagogy developed alongside technology. Data is collected through logs from hardware and also through video recordings of the whole class and of a smaller group. A lot of information is collected through interviews/focus groups/pre and post-experiment tests of knowledge and surveys/observation data/attitude scores. Qualitative analyses are planned using critical incident analysis of classroom interactions (videos, observations, surveys etc). Quantitative analyses will be conducted on test results, attitude scale scores, plus analyses of log data (no details specified). Results of data analyses will be fed into the interactive design process for the next evolution of the system. Results will be disseminated through academic publications, web demos and online photos/videos. Quite a few ethical issues identified with respect to dissemination - consent required from pupils and parents, issues mostly linked to 'too personal inquiry' issues and low parental engagement in terms of getting consent. One researcher highlighted the successful use of two cameras to capture classroom interactions (one on the class, one on a smaller group) and the information revealed through the log data. The other highlights how the critical incident analysis of classroom activity was useful.

#### **SynergyNet - Supporting Collaborative Learning in an Immersive Environment**

1 respondent: 0 Investigators, 1 researcher (web technologies – data mining PhD)

SynergyNet adopts a modular iterative prototyping and development incorporating student input at each milestone by means of collecting qualitative feedback on how good the current system is. These data will also be used after the design stage, for evaluation. Log data from use of the system by learners is collected and stored. User requests are recorded and stored for later analysis. This will supplement qualitative data from questioning users, and quantitative data. Machine learning by the system from the data was also mentioned. Data mining processes will take place on the evaluation data. A paper-based group survey is

planned for early 2010 - a reason for paper-based rather than an online survey was not given. An ethical issue, like hapTEL, surrounds the need for a control group and the ethics of offering only one group of students an enhanced learning experience. One respondent noted that finding out about other similar projects and related technologies was helpful to them.

### **Emergent cross-project issues:**

There are several opportunities for programme level project support. The one which was shared across the most projects concerned the coordination and synchronised replay of multisource data. Support regarding choosing and using appropriate computer-assisted qualitative data analysis systems (CAQDAS) would therefore clearly be useful. We will approach CAQDAS software experts to attend the Warwick workshop and give advice.

Quite a variety of CAQDAS software is currently available, including

NITE XML toolkit (<http://groups.inf.ed.ac.uk/nxt/>)

TRANSANA (<http://www.transana.org>)

INTERACT (<http://www.mangold-international.com>)

and

STUDIOCODE (<http://www.studiocodegroup.com>)

CAMTASIA, MORAE (<http://www.techsmith.com/>)

Projects might find the following paper useful - it provides a review of some of the computer-assisted qualitative data analysis systems (CAQDAS) systems listed above:

[http://www.lrec-conf.org/proceedings/lrec2008/pdf/13\\_paper.pdf](http://www.lrec-conf.org/proceedings/lrec2008/pdf/13_paper.pdf)

Other potentially useful CAQDAS resources include:

<http://www.eval.org/Resources/QDA.htm>

[http://onlineqda.hud.ac.uk/Which\\_software/reviews-of-sw.php](http://onlineqda.hud.ac.uk/Which_software/reviews-of-sw.php)

<http://caqdas.soc.surrey.ac.uk/QUICworkingpapers.html>

<http://www.ccsr.ac.uk/methods/festival/programme/cqd/documents/silver.ppt>

<http://www.docstoc.com/docs/13451778/Software-for-Analysing-Video>

<http://caqdas.soc.surrey.ac.uk/> (CAQDAS networking project University of Surrey)

and

<http://www.ncrm.ac.uk/> ESRC National Centre for Research Methods

A second TER related emergent theme concerned ethical issues. These included concerns around control groups being denied potentially useful intervention. For example, should control group participants be offered experimental interventions afterwards? It would be useful for projects to share their views on this.

The proposed Warwick workshop will provide opportunities to hear presentations on these two issues (and

others too). Importantly, it will provide a forum for the sharing of TER ideas and experiences with technology, software, and research methods by researchers from different projects.