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Smart Labs and Social Practice: Social Tools for Pervasive Laboratory Workspaces

A Position Paper

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Introduction

The emergence of pervasive and ubiquitous computing stimulates a view of future work environments where sharing of information, data and knowledge is easy and commonplace, particularly in highly interactive settings. Much of the work in this area focuses on tool development to support activities such as data collection, data recording and sharing, and so on. An illustration of the kinds of project in this area is provided below in the form of an announcement from Indiana University:

"Received funding for the first National Ecological Observatory Network (NEON) science project, entitled "Collaborative Research: Automating Scaling and Data Processing in a Network of Sensors: Towards a Global Network for Lake Metabolism Research and Education." This project seeks to build a worldwide network of instruments and databases for lake water quality to further understanding of the life cycles of lakes and the impact on lakes of human activity (Knowledge Acquisition and Projection Lab Indiana University)" <http://www.pervasive.iu.edu/lab/> accessed 28/10/05

We are interested in this kind of technical development, which is both challenging and essential for science communities. But we are also interested in a broader interpretation of knowledge sharing and the human/social side of tools we develop to support this. We are keen to know more about how groups of different kinds of scientists can make their work understandable and shareable with each other in a multi-disciplinary setting. This is a complex task because boundaries and barriers can emerge between disciplines engendered by differences in discourses and practices, which may not easily translate into other discipline areas. In the worst case, there may be some hostility between disciplines, or at least doubt and scepticism. Nevertheless, sharing approaches to research, research expertise, data and methods across disciplines can be a very fruitful exercise, and encouragement to engage in this activity is particularly pertinent in the digital era. Issues of privacy and security are also key aspects – knowing when and how to release data or information to other groups is crucial to providing a safe environment for people to work, and there are several sensitivities to be explored here.

In this paper we describe an evolving situation that captures many of these issues, which we aim to track longitudinally. The Faculty of Mathematics and Computing and the Institute of Educational Technology (IET) at the Open University (OU) are about to relocate together in a new purpose-built building with pervasive and ambient technologies incorporated into the fabric. The building will comprise of office space, communal spaces, and a laboratory which will include three specific components. The main part of the laboratory will be a highly flexible space, or "podium suite", with associated observation areas, where different realistic settings can be emulated. This space will enable user-focused experiments in a range of environments, where technology is present at varying degrees. The second aspect of the facility constitutes a unique feature: in order to be able to mount experiments covering transitions between environments, the Laboratory's advanced technical infrastructure will be pervasive throughout the whole building, and will support equipping and observing mobile participants across an area of the campus, including outside spaces. Thus, the facility will promote innovative research by enabling investigation of human interaction in closed, densely technology-enabled environments that contain participants as well as open, more sparsely enabled and less constrained environments through which participants move. We also intend the

laboratory to support groups of remote participants. Finally, the laboratory will include a dedicated demonstration area to be used for outreach and technology transfer.

This development provides great opportunity for researchers from different disciplines to share their research expertise with each other, and our task, on one hand, is to support them with tools to enable this. But we also intend to take advantage of the ambient and pervasive technologies built into the space to investigate the process of coming together – to turn the technologies on ourselves, in effect. This will raise various issues of privacy amongst the researchers which we need to address, and there are some key social factors which, however much we might prefer it, cannot be ignored.

The Context

In the Computing Department and in IET, researchers have varied backgrounds and conduct research in different disciplines: e.g. requirements engineering HCI, education, and business management. They are also involved in creating distance-learning materials, supporting and teaching lifelong learners or students, and managing synchronous and asynchronous on-line conferencing tools involving communities of students and tutors.

There are, therefore, some common strands of research shared between the Department of Computing, and IET: e.g. development of tools and technologies that support e-learning and collaborative computing [McAndrew et al., 2004]; design, usability and pedagogical effectiveness of web-based and mobile e-learning environments [Minocha & Sharp, 2004]; design of learning objects [McAndrew et al., in press]; and data-gathering tools and technologies [Brasher & Taylor 2004]; evaluation of the use of various technologies in distance learning [e.g. Taylor, 2004; Taylor et al, 2000].

However, some of the similarities are fairly superficial, in that the techniques and methods that underpin them may be very different. In requirements gathering, for instance, IET might be inclined to adopt a fairly soft methodology which could be regarded with some suspicion by the more formal requirements engineering community located within Computing. This is an example area where sharing information and approach is actually very informative and fruitful, but sharing will not necessarily happen spontaneously unless the barrier of approach is dismantled in some way. Similarly, sometimes research is undertaken in both domains which each group remains blissfully unaware of (e.g. some aspects of pedagogical design of courseware).

A further complicating factor is that whilst some staff in the Department of Computing and some staff in IET know each other, and the Department of Computing has existing relationships with the Department of Mathematics (its faculty 'other half') very few people in IET know the mathematicians and their research at all. In addition each researcher and research grouping brings their own collaborating group outside of the organisation. The joint community must develop respecting these existing activity structures and established communication routes.

The opportunity that is offered is to take the physical changes in environment and match them to new working methods supported by the adoption of appropriate technologies. A critical approach to be considered is a change to an open publishing approach to integrate new laboratories into the model of 'publication at source' for the benefit of local collaboration and to work within the framework offered by e-Science. The new forms of knowledge production will provide a focus for how we can achieve this, by scaling up our own experiences and by seeking to adopt best practice from the e-Science community. However, we are also very interested in the ethical issues that are raised and recognise that adopting some apparently open practices can inhibit individual actions and involvement.

The Task

We have identified three strands that need to be investigated within these working practices.

Strand 1: Supporting sharing in existing related research activity

There is a line of research in Computer Supported Collaborative Learning CSCL in both IET and the Computing Department which is now focussing on using the grid for training, education, collaboration, and e-research or e-scholarship. In fact, joint data gathering has been exploited within the OU course *The Environmental Web* (U316) [Young, 2003] which developed a task to produce a collaborative biodiversity map for the UK by collating data from students spread all over the UK.

The data in the different collaborative research projects in CSCL is being collated on a variety of projects by applying a wide-range of techniques ranging from direct observations to large-scale surveys. The data is recorded and collated in a variety of artefacts: as free-flowing notes in paper note books or in tables, in Excel, data on hand-held devices, video logs, audio logs, and so on.

Initially, our research efforts would be to develop tools to support the consolidation and analysis of this varied data. There would be a variety of issues and implications in this piece of research for grid-based e-research: e.g. how do researchers from different disciplines analyse and interpret the data? How should we design tools to meet the different needs of researchers accessing this data? What usability issues emerge from this activity?

IET has also developed an award-winning Knowledge Network [Rico, 2004], a University-wide web-based service that helps educators to contribute and access teaching experiences or educational research, and to create collaborative websites.

Strand 2: Construct learning scenarios-of-use for grid-based e-learning and e-collaboration.

Based on our research in CSCL, we will construct scenarios-of-use for grid-based e-learning and e-collaboration. These scenarios will involve access to distributed resources and computing on the grid. The scenarios will be developed and validated by applying a variety of techniques with students at the OU: activity theory, diary-keeping, observations to capture critical snapshots as a part of series of longitudinal studies with e-learners. These scenarios will guide the development of tools to support grid-based CSCL applications.

There are issues of trust, privacy and ethics related to the monitoring of learners, data-gathering technologies and use of research data. In one of the projects at the OU, we are currently exploring the privacy issues related to data-monitoring technologies [Joinson & Reips, in press; Joinson, 2001; Paine, Joinson, Buchanan & Reips, 2005]. We will use the outcomes of this research to support the design of data-collection tools, including the development and application of privacy-enabling technologies within pervasive research environments.

We will be using the OU's Knowledge Network as a knowledge-sharing (e.g. discussion forums) and knowledge-management tool [McAndrew et al., 2004] and evaluate its effectiveness to support knowledge management, communication, and multi-disciplinary e-research activities.

Strand 3: Develop new research activities through data sharing across disciplines

The third strand is the most challenging. The pervasive and ambient aspects of the laboratory enable experiments to be conducted which will be of interest and relevance to many other disciplines, besides the ones housed with the building itself (e.g. Education, Social Sciences, Psychology), all located elsewhere on campus) and, as researchers located within an Institution committed to openness, perhaps we should be espousing the principle that the University's investment in the laboratory is returned by the sharing of data amongst all these groups. The immediate problem is that they may not recognise the 'data' of one research community as data at all, or at least may seriously question the validity of such data. Therefore, simply making it available on-line in whatever format is unlikely to bring about mutual understanding. So what will it take to motivate and support researchers to come together and invest in understanding each other's research?

Tracking formal activity

There are some obvious academic tactics to deploy in this situation, such as joint seminars, lectures and workshops. Undoubtedly these will take place, and we can undertake observational study to analyse the

dynamics. Seminars/lectures will be webcast (or podcast) so that (a) people can join in from a distance, and (b) the events can be made available on-line for future use.

We can also use the embedded technologies of the building to support attendance at events, or to provide a news feed of exciting research activity or findings.

Tracking informal activity

Of course there are many other possibilities for activities capitalising on the embedded technologies, perhaps augmented by more localised artefacts (e.g. RFID tags), some of which may be innocuous, some of which may be regarded as invasive. For example, for the residents, tracking general movements through the building, knowing how much time was spent in shared areas and seminars, how much time spent in laboratory space etc. would be informative where such data is abstract. Similarly, tracking who enters and leaves the building would indicate the extent to which other faculty members were interacting with resident faculty. Observational facilities (e.g. digital video cameras) will also make it easy to keep a log of who is doing what in various specified areas of the building. Tagging pieces of equipment and devices can also yield information about when and where (and sometimes how) such devices are being utilised which may be useful data.

At this point, though, ethical issues begin to dominate the agenda. Is it right that we should conduct such research? How would researchers feel about being subject to the same observational techniques that they use in their experiments? Would the Unions have a viewpoint on this? Where would the data be stored? Who could look at it? Perhaps this approach will prove counter-productive in encouraging notoriously conservative academics to co-mingle. The form that such data is made available to researchers may ameliorate such effects (for example, processing of video data so that the real identities of individuals are not apparent before the video data is released to researchers). The nature of the processing required will usually be linked to the objectives of the experiment being carried out, and the nature of the raw data being captured. In these respects, the development of the algorithms and processes necessary could be looked on as one aspect of the 'sense making' processes discussed in the section 'Making sense of the data' (below). For example, to protect the identity of an individual, that individual must at first be identified (an aspect of 'sense making'), then steps taken to e.g. render them anonymous in the relevant video or audio data (e.g. by replacing their voice with a synthesised voice in the audio data). In this way the development of algorithms to make sense of video and audio data could be a prerequisite of automatic processes to protect individuals' identities within video and audio data.

Support Tools

In this setting, we shall also be considering what support tools are needed to help bridge between communities. We have to bear in mind that our communities consist of very busy academics, who will not necessarily respond positively to engaging in the rather self-conscious process of analysing their own requirements. It will therefore be a challenge to us to find ways of uncovering implicit needs and gaps that we can cover through a mixture of formal and informal activity.

Ultimately, we will need to develop a means of communicating (digitally and otherwise) that takes into account not only the scientific norms of each community, but also the social need of the group as a whole. Integrating the social or 'people' dimension in grid computing will accelerate how researchers work together. The Knowledge Network will provide one such avenue for e-collaboration. Technologies such as an electronic name tag from nTAG [nTAG, 2005] can help people within CRC and around the campus to find people and researchers with common interests. Instant Messaging (IM) is another application that's transforming the workplace. When IM is integrated with other applications, researchers can immediately chat with colleagues and collaborate more easily than if they had to telephone or e-mail.

Another type of socialisation occurs when teams work together and share information. A wiki, a shared space on the Web, is a powerful collaboration tool to build and edit content, increasing the collective knowledge of the group. Wiki, along with the Knowledge Network, can be used to share best practice and lessons learned in CSCL projects around the campus and within the wider e-learning community. Blogging, podcasting and video blogging are some of the other technologies that are shaping the social milieu in e-research and e-collaboration.

Making sense of the data

A data or information explosion is occurring where new types of data are constantly being generated by new devices. The data is getting messier, informal, unstructured and is coming in different formats: documents, text messages, pictures, video clips, audio clips.

In our initiative, we will also have to address the ‘extreme data’ problem [CSC, 2005]. The incoming data will arrive from different sources but advances in searching, semantics, visualisation and pattern detection will be required to derive meanings from the data. We will, therefore, be considering search and information management tools which will help to search, query and integrate information from the vast repository of text, images, video and audio. Such tools will also help researchers mine their own documents for needed information. Research in meta-data – data about data – will enable encoding of meaning with data, making the data easily searchable and retrievable. A thesaurus or taxonomy of the meta-data will help collaborators to understand how the data is organised. Pattern detection tools will help detect patterns and integrate the information for visualisation. Visualisation techniques will analyse the large data sets and present the patterns and relationships to support a collaborative sense-making.

Conclusion

This position paper outlines the view that whilst tools to enable data sharing and associated activities is essential to the development of e-laboratories, there is an equally important strand of research which is receiving far less attention: that is the social aspects of sharing amongst scientists, and the supporting work that needs to go on to ensure that such collaborative work actually emerges from sharing practice.

The project detailed here aims to address this strand within the overall milieu of supporting the more usual kinds of activities through a knowledge network, taking advantage of a unique situation which has arisen. The findings will be relevant more broadly than this particular example, though. Many of the issues we raise will be receiving preliminary attention in an EPSRC bid currently in submission.

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