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Workplace personalised learning environments for the development of employees' technical communicative skills

RESEARCH REPORT

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Note. This short development project had as its major aim, the elaboration of two scoping reports – Reports A and B. Some of the text below is taken from these reports in order to report on the development of the project. The reports are available for download at http://www.workplace-ple.org/ and it is here that comprehensive examples and references will be found.

1. Background

This six-month development project sought to address a widely-recognised problem with skills in the UK economy, namely the need to move away from the existing "low skills equilibrium", where many jobs are based on low specifications and consequently require a relatively low level of skills, to one with a significant number of higher quality jobs that will contribute to improved services and more effective organisational performance.
In addressing this problem, we based our approach on the identification of two key knowledge components. The first was the requirement for advanced communication skills and understanding (ACSU), the facility to communicate knowledge within and beyond the working context. The second was the need for an awareness of the models that underpin the IT systems used in modern workplaces, and enough understanding of them to be able to interpret their output: Techno-mathematical Literacies (TmL). The key task for our development project, therefore, was to outline the design of a *workplace personalised learning environment* (WPLE) that could support the development of Technical Communicative Skills (combining ACSU/TmL, TCS).

This research involved the formation of an interdisciplinary research team, drawing on existing research expertise in three required areas:

- education research and the development of new educational technologies for TEL;

- labour market and career guidance research

- computer science research on personalised and adaptive learning systems

We expected that formation of the team — development of shared perspectives and language, etc — would take a substantial amount of effort and this proved to be the case.

2. Objectives

The aims of the project were to:
a. conduct a programme of inter-disciplinary seminars and workshops through which researchers and users would:
- develop a shared understanding and language with which to frame collaborative challenges of social science and computer science in developing TCS in the workplace;
- produce collaboratively two scoping reports: Report A to define the nature of TCS skills building on prior work on ACSU and TmL; Report B to set out the requirements for the development of TCS, and outline a specification for a WPLE to support the development of TCS in the workplace.

b. produce a jointly-developed demonstrator for a WPLE based on collaboration between the research teams. The demonstrator would be web-based and developed using existing software so as to present the scope of the envisaged WPLE functionality but with no implementation of adaptation and personalisation functionality, learner models, etc.

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c. clarify the objectives and methodology of a full-scale proposal to the second call of the Technology Enhanced Learning programme, and establish appropriate partnerships with other researchers and users.

All of these aims were successfully achieved.

3. Methods

The research work developed around five one-day research seminars, with a number of additional preparatory and working meetings. As an interdisciplinary development project, our priority was on maximum team engagement and shared production of ideas, writing and software prototypes.

We also conducted intensive user engagement, using existing networks of contacts in the IAG sector from Warwick, and in the financial services sector from IOE. The second project seminar (January) was dedicated to a user consultation exercise, and this was followed by further informal discussions, and a short programme of user trialling of our WPLE prototype materials at the end of the project (three semi-structured interviews with IAG experts, and a focus group with eight post-graduate students in an IAG course).

4. Results

4.1 Defining the scope of the development project

Our initial intention was to investigate several workplace contexts as exemplars of TCS:

- Financial advisers in financial services companies;

- Information Advice and Guidance (IAG) services

- Aerospace supply chain as an example of a set of organisations deploying training

    resources to support high value-added, knowledge-intensive work.

Early on in our joint seminars, it became clear that work in Aerospace would not be viable. The companies already had training resources in place, which addressed TCS issues, but for reasons of commercial sensitivity they did not wish to disclose the detailed operation of their skills development and utilisation system. However, we remained (justifiably) confident that we could address the issues within existing alternative sites.

A further reorientation emerged from our early deliberations. At the January *user consultation* seminar, we presented our ideas to practitioners, trainers and managers from the careers guidance and financial services sectors. The participants suggested that rather than addressing careers guidance within an ACSU framework and financial services, primarily from a TmL perspective, it was suggested that we should *focus on careers guidance and the need – within it – for technical communicative skills*.

This approach was based on the recognition that financial considerations were becoming increasingly important for many clients and there was a compelling case that financial planning considerations should be an integral part of any future forms of careers guidance.

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For example, given that young people now have to pay for their higher education, decisions about whether to take a particular field of study, or vocational training, are essentially – as one user put it – "*investment decisions*". Additionally, we judged that there would be no loss of generality to our findings on how to develop a WPLE to support the development of TCS in this context, since the approach could still be generalised horizontally across sectors and workplaces, and vertically through different educational sectors.

4.2 Preparing the framework for the WPLE demonstrator

We identified two main areas of technical expertise required by careers practitioners: i) understanding Labour Market Information (LMI) and ii) the need for career guidance to be informed by financial planning.

Labour Market Information (LMI)

Labour Market Information is regarded in government policy as a crucial element in guiding young people and adults towards appropriate jobs and educational opportunities: information includes where jobs are, what sectors of the economy they are based in, local and national trends in the numbers of jobs of particular types, areas of skills shortages.

In addition to policy analyses pointing to the need for more LMI-focused guidance, Information Advice and Guidance practitioners have acknowledged that recent practice has underplayed the importance of LMI. For example, we noted that the job roles of LearnDirect Advice employees have been expanded to include the provision of more specific and technical advice.

Labour Market Information refers to both quantitative (tables, maps, graphs) and qualitative (reports, newspaper articles, anecdotal information) data. *Labour Market Intelligence* refers to information that is the result of analysis and interpretation of LMI. The statistical nature of quantitative LMI presents significant conceptual challenges to those who need to develop Labour Market Intelligence. Statistical data are fundamentally based on the aggregation of samples of individual cases, out of which are calculated statistics (especially, averages and ranges) which summarise the sample data. A major conceptual difficulty for clients, and the careers practitioner advising them, is to perceive *their own individual case in relation to the summarised sample.* This is a general problem known in the educational and psychological literature (Shaughnessy, 2007).

Technical Communication Skills for LMI therefore require the technical facility to understand and interpret LMI, combined with the facility to communicate Labour Market Intelligence to clients in ways that place them in a context of what this intelligence means for clients' career decisions, that is, in a form that can:

- assist individuals in interpreting and using current LMI for career planning;

- comprehend and critically evaluate local, regional, national and international LMI;

- access information on past and present labour market needs and future labour market trends.

Hence, we came to see the case of LMI as both a practically significant and conceptually-rich case of TCS for the purposes of research, and a challenge in terms of the development of a

computational system to support the development and communication of Labour Market Intelligence.

Financial planning and career guidance

Our consultations with the IAG community have shown recognition of the expanding role financial planning needs to play in the provision of effective career guidance. As well as a need for clients to understand the type of technical issue highlighted above, guidance needs to be placed in the context of underdeveloped financial understanding amongst the general population. Both financial and career planning are fundamentally underpinned by TCS and as we began to share our vision of a demonstrator to representatives of guidance and financial services practitioners at the consultation seminars, they endorsed our view of the utility of such a system.

Some guidelines for TCS in this context can be drawn from the work done by the Techno-mathematical Literacies in the Workplace project [1] in financial services companies. Amongst employees outside the relative few employed in technical departments, we found little understanding of the workings of compound interest or loans/mortgages, which are the most basic models used in saving and borrowing money. All calculations were entrusted to the computer systems, and very little knowledge was expected of employees in sales or customer services about how these calculations work. Nor was it normal to offer training in such knowledge. In some areas of operation, where the work was predictable and routine, this did not matter (for example, processing the maturation of an investment bond). However, the TmL findings illustrate areas of sales and customer services where communication with the customer was core to the work, and the changing patterns of customer concerns implied that technical knowledge for the employee was becoming increasingly important. The TmL project findings demonstrated that employees with TmL gave a company an edge over its competitors in terms of improved customer engagement.

Thus the situation in financial services companies shows a requirement for TCS that is analogous to the situation in careers guidance: a need to understand underlying technical relationships and how they relate to the needs of customers and to be able to communicate this understanding in ways that take account of the client's needs. In the TmL project, a successful approach was based on identifying symbolic artefacts in the practice (such as annual valuation statements about a pension, or graphs of loan/mortgage repayments). These putative *boundary objects* could then act as a basis for the development of software tools that allowed employees to engage directly with the mathematical models of compound interest and loans using, for example, spreadsheets or specially-designed tools (see http://www.lkl.ac.uk/tml/financial.html). In the TmL project, we named these 'Technology Enhanced Boundary Objects' or TEBOs. We elaborate this idea below.

Towards a pedagogical and technical approach

The workplace context raises interesting questions for a viable pedagogy to enhance TCS. In the TmL project, and in early phases of this WPLE development project, we observed that workplace training tends to adopt a largely transmission model of "delivering" material rather than allowing for exploration, questioning and learning from feedback. This is especially critical in the case of mathematical knowledge, where the algebraic formulae that are the standard representation of mathematical procedures are difficult for trainers to handle and

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[1] ESRC award number RES-139-25-0119, Hoyles & Noss.

tend to invite "safe" training that ensures that mathematical material will either be "covered" superficially, or ignored altogether.

Our approach, developed within the joint seminars and based on our findings of the TmL project, was to design TEBOs which offer alternative representations for mathematical knowledge, and make possible engagement with mathematics through authentic activities based around exploration, discussion and joint problem-solving.

4.3 Elements for specification of the WPLE

The core technical idea of our WPLE would be to exploit the potential of combining adaptive computation with social/collaborative working through Web2.0-style applications. Practitioners would need to draw on their experiential knowledge and familiarity with guidance practice as well as engage in a programme of individual and collaborative learning of TCS.

We now outline four key elements which we have identified for personalised learning of TCS.

Boundary objects, TEBOs

In the research of the TmL project a particularly fruitful way of thinking about the nature of skills gaps and skills development was to look at the boundaries between different communities of employees within a workplace and the symbolic artefacts (documents, graphs, computer software) that are used to communicate between communities. We developed an approach to learning based on the design of technologically enhanced symbolic boundary objects: we noted that symbolic information in the form of numbers, tables and graphs was in general a poor facilitator of communication across community boundaries in the financial sector, such as between customers and customer service teams, and between service teams and technical consultant experts (whose input is required to answer complex customer questions). We found that effective learning of TmL (and by implication TCS in the present project) could follow from engagement in authentic activities that embedded mathematical models which were made more visible and manipulable through interactive software tools; that through engagement with TEBOs.

"Client scenarios" as the basis for learning and application of TCS

The work of the guidance practitioner is focused on the needs of the client in front of them. Thus, it is necessary to relate the knowledge that can arise from LMI and financial planning to the needs of that client. However, in many circumstances of guidance (say, a 15 or 30 minute interview) it seems that there is not likely to be time for the kind of detailed exploration of personal circumstances, which would be required to match up to a detailed LMI analysis. Rather, what happens is that practitioners develop a repertoire of typical client scenarios and guidance issues, which they draw on in interviews with clients.

We decided to develop the same approach in the WPLE demonstrator. A set of client scenarios would be developed to correspond to different guidance issues and the application of relevant LMI data or financial planning methods. A major part of learning in the WPLE would be to develop a thorough knowledge of a wide range of scenarios and, through these, the development of TCS. Moreover, for practitioners to learn to apply technical knowledge to practice there would need to be the possibility for them to build modified sets of scenarios as part of their personal learning resources within the WPLE. It is also likely that for a guidance

organisation to implement the WPLE, a key step would be to modify and extend the "basic" set of scenarios provided by the initial system developers.

Social and conceptual elements

Our proposed development of a WPLE needed to take into consideration the functionalities that are typical of personalised learning environments as they currently exist. A key design goal of the proposed WPLE is to place the locus of control with the learner, both in terms of the desired approach to learning, and the nature of appropriate technological support. There are established "Web2.0" services that provide such functionality for different aspects of information and communication (blogs, social networking, databases, internet-based office applications, etc) and there is a tendency among Web2.0 advocates to invoke a host of different applications for every user. Our experience[2] in delivering web-based support for continuing professional development suggests, however, that a *small* subset of the wide range of possible services can be most effective to keep learners "on task", where above all the requirement is to offer support for learning and development without distracting the learner at the same time.

In our context, the key feature of Web2.0 services is the way we can exploit them to draw cumulatively on the experience of practitioners, for example, offering the ability to "upload" to the WPLE contextualised examples of what they did in practice to use WPLE resources in ways that proved meaningful to their clients.

After investigating a wide range of Web2.0 services, an important task was to identify the *minimal set* of tools necessary for us to achieve our purposes of transforming approaches to the learning and development of TCS. However, our main innovation was to find ways to integrate TEBOs into the framework of the WPLE, as exploration with interactive conceptually-based tools is a novel addition to a Web2.0-style assembly of services – but a crucial one for a WPLE to develop TCS. For most practitioners interested in developing their TCS the most important facilities were likely to be able to plan, develop and reflect upon their learning, development and implementation experiences, and for users to have the facility to adapt, or in some cases develop, TEBOs and related learning resources for themselves.

Outlining a role for modelling of the user in an adaptive system

The project team also investigated whether it would be possible to go beyond the functionalities associated with a typical personalised learning environment, and to consider whether it would be possible to develop a system that drew upon *modelling of the user* and *adaptive system behaviour* (for general background, see: Brusilovsky, Kobsa, & Nejdl, 2007; Chen & Magoulas, 2005). This type of approach would be largely centred around supporting interactions with TEBOs and could involve system functionalities such as:

- personalised recommendations for learning opportunities;

- adaptation of the sequencing of learning activities;

- adaptive generation of collaborative learning activities responding to the needs of communities of learners with similar or complementary skill profiles

- collecting and organising expert models of practitioner knowledge and practice.

A system of this kind would interact with the user "intelligently" by utilising user-related information, in order to adapt the applications' contents and presentation to the user needs,

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[2] in developing and operating the National Guidance Research Forum, www.guidance-research.org .

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goals and interests. To this end, an understanding of the users, and their cognitive characteristics, goals and domain knowledge is needed. This understanding about users can be achieved through a user modelling process by means of a user-guided approach, in which user models are created on the basis of information provided by each user or an automatic approach, in which the process of creating a user model is hidden from the user. Both approaches are relevant to the functionalities intended for the WPLE.

4.4 The WPLE Demonstrator

The Demonstrator[3] presents the scope of the WPLE functionality through an example of how an individual learner might move through the WPLE. It includes a static case of what would in practice involve learners making choices in their routes, dependent on the context for which they were using the system, their learning needs and their past experience. The key intention of the Demonstrator is to show the possibility of exploration-oriented learning organised around flexible pathways – called *learning trails*. Learning trails are pathways where users can, at appropriate times, make use of a range of TEBOs, learning materials, scenarios, communication tools, information gathering/filtering tools and other external tools, aimed at achieving a particular set of goals.

For most users, it is expected that they will start by working through one or more scenarios that are based on examples of practitioner/client interactions. The scenarios are intended to highlight the need for clients to develop their TCS and thus practitioners could choose to develop their own TCS in relation to the issues highlighted. It would also be possible for users to undertake an individual audit/self assessment of their TCS.

Once the need has been established for some TCS development, users should be able to embark on a learning trail that offers alternative ways of representing, understanding and interpreting Labour Market Information in the form of tables and charts, including helping users to understand the underlying statistical and labour market concepts. Some of these materials may be simple boundary objects (tables and charts with explanatory text). Crucially there will also be TEBOs, powerful, dynamic representations of these boundary objects that allow for interaction and could help transform how practitioners view the relationships between data. Users will also be provided with access to some specially-prepared LMI data sets with which to explore LMI trends, how financial and career planning are becoming entwined, and to reflect upon how best to draw on this information when working with clients. The practitioners will be able to choose the information they wish to explore and will also have access to communication / reflection tools in order to help them work on the chosen data sets. The Demonstrator will also provide sections that will enable users to browse frequently asked questions or to enter their own questions.

Below is an example of a scenario through which practitioners might start to engage with client concerns about their career and financial planning:

> I am 32 years of age and have been working as a non graduate engineer since I dropped out of university when I was 22. In the last four years I decide I wanted a career change and that I also needed to obtain better qualifications. So I have recently obtained a 2:1 in Business Studies by distance learning from De Montfort University, Leicester and I am now studying full time for an MSc in Economics form Birkbeck College, University of London (which finishes in June 2007).

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[3] See Scoping Report B, and website: www.workplace-ple.org/demonstrator .

> As I took out a career development loan follow my postgraduate study, I need to find a job as soon after the course finishes (September 2007) so I can pay back the loan. I have been looking at jobs and would ideally like a graduate position with good prospects that will make my career investments worthwhile. As a start, I have an application for the Institute of Fiscal Studies for the position of research economist, but after doing some digging into employee profiles I have some concerns about my prospects that carries through to all potential jobs and would like some advice.

Scenarios such as this will highlight the importance of a number of key issues furthering career planning: issues of debt, client wants a return on career investment (loan), net present value, compound interest, future salary, employment opportunities, geographical opportunities and differences, required skills / training, aspirations for a major career change, 'jobs with prospects'.

The user can find out more about these key concepts by using TEBOs that can act as a bridge to more technical, symbolically-expressed understandings and representations than are currently used by the majority of practitioners. However, users need not only to understand and interpret the relevant technical information but also to be able to use it with clients. So there will also be a range of community 'discussion services' that will provide support for the collective development of case-based knowledge about how practitioners could use LMI and financial planning with a client. Additionally, as part of a general resource centre, there would be video and audio clips of guidance sessions where data are being used; case studies of how information is used, and examples of a range of practices.

Working in this way may also lead practitioners to engage with more comprehensive LMI, which in turn may mean that practitioners could see that there are other scenarios that could be developed to treat this issue that are more relevant to their own particular context. It may be that a number of learning trials and TEBOs dealing with particular technical issues could be aggregated to address a particular guidance issue. In these cases the designers could work with practitioners in order to construct a complete learning package.

As practitioners follow a particular learning trail, including working with TEBOs and other learning resources, they also can work with LMI data sets along with communication and reflection tools in order to develop their TCS and how they might use these skills. The WPLE will provide:

- A personalised space for reflections;

- Tools to add to or annotate charts and data;

- Tools to upload materials, add case studies, annotate articles/case studies/relevant documents;

- Options to invite others to see selected elements of the WPLE;

- Tools to record training/qualifications and learning outcomes and to set targets, plans and goals;

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- Tools to identify materials to read at a later date and to print, save, email and export options.

One key area for TCS development is to enable practitioners to engage clients with LMI-informed career and financial planning information. Given that communicating such information is itself a real challenge, it is important that practitioners have opportunities to discuss how their TCS development informs their practice in a community discussion blog. In order to help practitioners a range of opportunities are offered for discussion around topics such as those outlined below:

Communicating – Discussion opportunities:
- How do I get the message across?

Researching and seeking information:
- Where do I find out?

As well as supporting individual and community development, the demonstrator also highlights how designers could work with practitioners in order to construct a complete learning package. It may also be that an organisation working in this field (for example, a sector skills council or a guidance organisation) may want to create a set of their own learning trails and TEBOs for use in a particular context.

5. Activities

The research team participated fully in the programme of TEL seminars and events organised by the TLRP (see main form).

6. Outputs

The research generated three outputs as a result of its interdisciplinary development work, all of which can be accessed via the website, www.workplace-ple.org :
- Scoping Report A: The Nature of Technical Communicative Skills and an Outline of a Career Guidance and Financial Planning 'Workplace Personalised Learning Environment'.

- Scoping Report B: Requirements Description and Specification of a Career Guidance and Financial Planning 'Workplace Personalised Learning Environment' System.

- Software Demonstrator: a web-based mock-up to present the scope of the envisaged learning resources and system functionalities.

7. Impacts

The ideas and proposals generated by the research were discussed with a range of users from the careers guidance community, including at the end of the project, a small user trial of two prototype TEBOs and associated activities and learning trails that we developed. The

feedback was obtained through interviews with four senior guidance practitioners and a focus group meeting with eight student practitioners. There was broad agreement with the idea that use of LMI is gaining a higher status in practice, and that there is a lack of skills to deal properly with LMI. There was also agreement with the characterisation of the problem of statistically-expressed LMI as helping the client "to find themselves in the data" (see Report A). The prototype TEBO for LMI was particularly successful, in offering a tool that maintained a clear relation (from the user's point of view) between the individual case and the statistical summary that emerges from the analysis of many cases. See the Tinkerplots screenshot below:
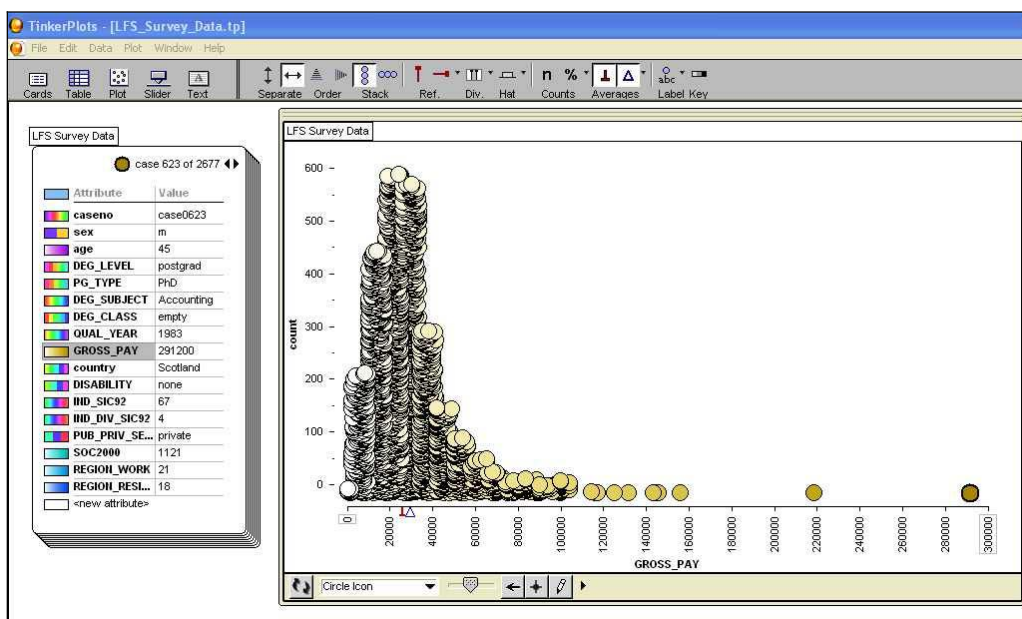
This screenshot shows a histogram of the distribution of salaries in a sample data set. By clicking on any button, the data for that button appears in the data card window on the left - the highest-earning case in the data set has been selected (middle-aged male working in financial services - not too surprising!)

More generally, there was positive support for the idea that TCS for financial planning could play an important role in enhancing practitioner's abilities, and that a WPLE with the range of functionalities offered in the demonstrator would fill a gap in available provision.

8. Future research priorities

The results of this project are being deployed in ongoing research and development for the IAG sector at IER Warwick (see main report form).

The team submitted a proposal for funding under TEL Phase 2 (ESRC Reference ES/F030657/1) for a project on the 'Design of a technologically enhanced learning system to support the development of an innovation community for guidance practitioners' (see Report B, Appendix E). to the research proposal is the tangible outcome of the joint endeavours of this development project and sets out a continuation of the interdisciplinary approach to TCS development.

We conclude with one observation that we think epitomises both the difficulties of interdisciplinary research and the possible ways to overcome them. When we began our deliberations, we were acutely aware of the interesting differences between our approaches. As our discussions developed we all sensed a convergence of our understanding, and the

evolution of a common purpose. Yet it was only when we began jointly to create actual system designs and to consider prototype TEBOs that differences began to re-emerge, and misunderstandings (mis-readings of each others' perceptions) could be negotiated. Thus the TEBOs not only fulfilled their goals within the proposed WPLE but also, in their design and development, forced us to consider more carefully our own assumptions and approaches, to understand better the ways of thinking of our colleagues, and finally to negotiate a common set of meanings and agendas: that is to facilitate boundary crossing across the communities represented in the project.

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