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

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SCOPING REPORT A

The nature of technical communicative skills and an outline of a career guidance and financial planning 'Workplace Personalised Learning Environment'

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T·L·R·P TEACHING & LEARNING RESEARCH PROGRAMME

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1. Introduction and Background

This report scopes out the nature of technical communicative skills (TCS) building on prior work on advanced communication skills and understanding (ACSU) and on techno-mathematical literacies (TmL). It then goes on to consider the extent to which these skills may be developed through the use of technologically-enhanced learning and whether this support can deliver a personalised learning experience. These issues are treated at a general level in this report as considerations of how such a system might be operationalised are considered in Scoping Report B.

1.1. Background

This report is based on research carried out by an interdisciplinary team of mathematics educators, employment researchers, guidance practitioners and computer scientists. The idea of technical-communicative skills (TCS) emerged during the creation of the funding proposal for this project. In the proposal we noted that there was a widely-recognised problem with skills in the UK economy, in that the country must 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 majority of higher quality jobs that will contribute to improved services and more effective organisational performance.[1] We also asserted that there were two key areas where employers repeatedly reported skill shortages, with evidence consistent from a wide range of sources[2]. The first shortage related to being able to communicate fluently and effectively with diverse audiences, advanced communication skills and understanding (ACSU), that require a combination of written and verbal skills and 'influencing skills' (Felstead *et al.*, 2007) with a growing emphasis on the verbal communication in both public and private interactions. The whole area of skills and career development has been a major research focus of the team from Warwick IER, both generally (Brown, 2004a; 2004b; Brown *et al*., 2000) and particularly in relation to careers guidance (Bimrose and Barnes, 2006; Bimrose *et al*., 2004). The second shortage related to having some 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. This has been the focus of the IOE team in their project 'Techno-mathematical Literacies (TmL) in the Workplace', which identified the TmL needed in manufacturing and financial services sectors and co-designed, with employers, learning opportunities for their development (Bakker *et al*., 2006a and b; Kent *et al*., 2007; Hoyles *et al*., in press)[3].

In the proposal, we noted that there was an additional challenge when communicative and

[1] See Wilson and Hogarth (2003).

[2] Sources include national labour market projections (Wilson, Homenidou & Dickerson, 2006), a major national investigation into the causes of skills deficiencies (Hogarth and Wilson, 2001), three national skills surveys (Ashton *et al*. 1999; Felstead *et al*., 2002; Felstead *et al*., 2007). The National Skills Task Force also evidenced the demands for employees with 'modern' skill sets, including abilities to work in teams and communicate effectively (NSTF, 2000).

[3] See project website for publications: www.ioe.ac.uk/tlrp/technomaths .

technical skills requirements were needed in combination, which we named **technical communicative skills** (TCS), the skills that underpinned effective communication of techno-mathematical knowledge. We therefore proposed to explore how TCS could be developed at work. One challenge identified was that employees would have 'spiky profiles' (i.e. their skills may be much greater in one area than another – thus, they could have strong technical expertise or communicative skills, but not both). A second challenge is the limited capacity amongst trainers and managers to recognise the skills requirement, and to communicate with technical expert teams in order to develop appropriate training. Thus there is a two-way communication gap, with a need for upskilling in TCS among managers, trainers and technical experts alongside upskilling of employees. The previous research of these two teams had also pointed to serious gaps in **training provision** for TCS skills in workplaces. We noted that in many settings there had been a high degree of organisational change that placed increased demands on staff, whereby they felt they had little time to participate in face-to-face courses or even fully engage with generic on-line learning material that was becoming more widely available. This background suggested a strong potential for technology-enhanced 'personalised learning' as a means to support TCS development. Birkbeck's computer science researchers joined the project to contribute their expertise in personalised learning systems.

In summary, this development project presented an ideal opportunity for the three teams from different disciplines to address a major challenge for skills development, and exploit their complementary expertise to design a flexible, adaptive and personalised learning environment that would support the development of TCS in the workplace. During this process the team would also explore issues of inter-disciplinarity while negotiating a common research agenda, based upon the project objectives. The objectives were:

1. To 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 on TmL; *Report B* to set out the requirements for the development of TCS, and outline a specification for a workplace personalised learning environment (WPLE) to support the development of TCS in the workplace.

2. To produce a jointly-developed demonstrator WPLE based on collaboration between the research teams and at least one major user. The demonstrator system to consist of a web-based user interface, developed using existing software so as to present the scope of the envisaged WPLE functionality and some mock-ups of personalised screens. This demonstrator would not include the actual adaptation and personalisation functionality, metadata repositories, activities, learner models etc. all of which would be part of a follow-on research proposal.

3. To 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.

1.2. Contexts of implementation

In the original proposal we proposed to investigate several workplace contexts as exemplars of TCS: namely financial advisers in financial services companies, who need to be able to understand financial products sufficiently to appreciate their merits and disadvantages according to different personal needs, and to communicate personalised advice to customers about the purchasing of financial products; Information Advice and Guidance (IAG) services in which employees have to understand the changing labour market, and help their clients understand these changes in order to give timely and relevant advice; and an Aerospace supply chain as an example of a set of organisations which deployed a wide array of training resources (including aspects of TCS) to support high value-added knowledge-intensive work.

Companies within the Aerospace industry already have in place effective systems to deliver TCS, and training resources in place from which we planned to learn. However, for reasons of commercial sensitivity, they did not wish to disclose the detailed operation of their skills development and utilisation system in anything other than general terms. This commercial sensitivity was exacerbated because major delays in the development of new aircraft had created a context in which there was likely to be organisational restructuring and job losses. Given this situation, the project team decided it was inappropriate to undertake further work with the company at this time.

The project team started their work in November 2006 by trying to refine the concept of TCS and elaborate detailed accounts in two separate, sample contexts, IAG and financial services, overseen by the IER and IOE teams. However a major change was prompted by the project's user consultation seminar in January, 2007. This seminar was attended by 20 people from the IAG and financial sectors, and the day started with an overview of work to date from each team as well as some outline ideas for the Workplace PLE (WPLE) that was to be designed. Two parallel group sessions were then formed according to the user context and the groups discussed possible ways forward for development work in their sector.

When the groups came back together to report on their deliberations it became clear that there were very strong similarities and that the two groups could learn much from each other. Accordingly, following a suggestion of a user, which was immediately endorsed by other participants, it was felt that the most interesting challenge would be to combine the two approaches and focus upon a single integrated topic, which drew upon both lines of enquiry, by studying financial planning *within* careers guidance. Thus the participants suggested that a useful way forward was, instead of considering career guidance and financial planning as separate contexts, to investigate whether these two areas could be brought together. The team decided this would assist in the inter-disciplinary development of the research: all team members would work together on a single integrated theme. The major advantage would be that financial considerations were becoming a more important issue for many clients and that financial planning considerations should be an integral part of any future forms of careers guidance. For example, for most people considering undertaking a period of education, there were implications in terms of borrowing money for tuition fees and living expenses, and the need to recoup these expenses through improved earnings in future employment. One participant, with a strategic position in terms of national delivery of adult guidance, summed this up as "the world of careers advice is moving closer and closer to the worlds of financial advice – young people are now expected to pay for higher education, and it's likely we'll see the re-introduction of learning accounts for young adults. *All of those are then fundamentally investment decisions*". What is

more, this shift was moving guidance practitioners into territory where they themselves felt the need to improve their own understanding before they would be able to help their clients. Thus, while we had already conceived of guidance practitioners needing development in their TCS in order to help their clients understand technical labour market information (for example about influence of replacement demand for occupations meaning that jobs that were declining in absolute numbers may still have more vacancies than jobs that were expanding), the importance of TCS was further strengthened by the suggestion of a financial planning dimension within guidance.

Additional to this emerging line of combined research, we had noted during our initial discussions in the financial sector that access for fieldwork was becoming increasingly challenging and the fruitful contacts in this sector that had been established by the TmL project looked problematic within the short timescale of the project. One company, whose senior training manager was broadly supportive of the need for TCS upskilling in his organisation, was ultimately unable to commit resources or provide access for the research due to major company reorganisation. A second company invited to participate agreed that TCS was a crucial and growing issue, but that the company's strategy was firmly to outsource such higher-level skills to other countries where capable, English-speaking and relatively low-cost graduate labour forces can be found, and not attempt upskilling within the UK.

Following reflection and discussion, we decided for the remainder of the project, to focus on one context of implementation only that would allow us all to work with one clear set of TCS aims and with one user group, namely that of **careers guidance with financial planning**. We judged it would be hugely beneficial for the team in developing a shared perspective of TCS and the WPLE, if all the team could work together using their different expertise on a **shared problem with the same group of users,** thus enhancing the possibility of an interdisciplinary approach. 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, since the approach could still be generalised horizontally across sectors and workplaces, and vertically through different educational sectors. We note here the advantage of funding for a development project, which provides the space and time required for collaborative endeavour. This is needed first, to work out the most productive way forward and second, to design appropriate strategies together. It should be noted that essentially the aims and priorities of the project remained unchanged, but the interdisciplinary collaboration itself enriched what the project team were trying to achieve and helped us to identify the most appropriate user focus.

2. Technical communicative skills (TCS) in the workplace: General trends

2.1. The low skills equilibrium and the drive for upskilling

The idea of developing employees' TCS can be located within attempts to move large parts of the UK economy away from a 'low skills equilibrium', in which employers and employees become trapped in a pattern of supply and demand focused on low specification, low value-added work that requires a low level of skills and pays relatively low wages (Wilson & Hogarth, 2003). There is a national policy drive towards upskilling with the intention to create higher quality jobs that will contribute to improved services and more effective organisational performance (Leitch, 2006). This policy recommendation is based upon a perception of a 'systems failure' over many years in vocational education and training that has been unable to support the required upskilling of the workforce, particularly in relation to the development of intermediate-level qualified workers (Leitch, 2006; Westwood, 2003). The Hutton (2005) report argued that Britain suffers from a legacy of low levels of basic skills for many workers, moderate educational achievement, and an incoherent and insufficiently valued skills training and skills development system. The evidence did suggest, however, that skill levels are rising and that the UK does have emergent institutional infrastructures to support the move from a low-skills/low-tech equilibrium to a high-skills/high-tech economy.

Even if a less sanguine view is taken about the speed of development of learning organisations (Brown and Keep, 2003), or the actual strength of demand for highly-skilled workers in the economy as a whole (Felstead *et al*., 2007), it is beyond question that upskilling is necessary and urgent in some sectors and that both technical skills and communication skills, particularly 'influencing skills', are attracting a premium in the current labour market (Felstead *et al*., 2007). One major trend, which links both these sets of skills, can be seen in service industries where there is a need to offer higher levels of service to customers, involving a greater degree of understanding of customer requirements, for example in order to explain to customers more of the technical details of a company's products/services. Two such sectors which have been investigated by members of the research team in previous research are: Information Advice and Guidance (IAG) services, such as careers guidance services for university students; and retail financial services (pensions and investments, mortgages, loans, etc.) These trends for TCS development are also apparent in manufacturing, where they have been formalized within different versions of continuous improvement or process improvement programmes.[4]

However, while there is evident demand for TCS in service delivery, it is a more open question whether companies will upskill their UK workforces to achieve this goal. For example, our consultation with several financial services companies showed that alongside an appreciation of the need for upskilling and more customer focus, there were contrary trends with as yet unclear implications for UK employee skills. In our user consultation, the view from a senior training

[4] UK manufacturing industry is facing the need to adopt more productive and higher quality work processes, as is typical of "Japanese style" manufacturing processes: e.g., Toyota system, statistical process control, Six Sigma (Brown et al., 2004; Hoyles, Bakker, Kent, and Noss, in press; Bakker, Hoyles, Kent, and Noss, 2006).

manager from one of the top five financial services companies in the UK was that employees could and should be developed to higher skills levels. However, the view of another senior training manager in a different top-five financial services company was that the need for such skills is increasing but it will be outsourced to India and (increasingly) Eastern Europe where English-speaking, technically capable and relatively cheap graduate employees are readily available, leaving UK-based call centres to handle only low-level, administrative customer services.

Overall, this means that upskilling is not a sufficient condition to guarantee a move towards higher skilled jobs, but the level of TCS amongst UK employees is likely to influence the decision as to where large companies site particular types of work.[5] This trend has consequences for how employees go about developing TCS – they cannot rely on their companies providing training, if companies can either export work, or import individuals with such skill sets from elsewhere (given the flow of migrant workers to the UK). If upskilling could make use of technologically-enhanced learning resources and systems that are flexible and adaptive to individual requirements, then this approach may offer a viable strategy for employee upskilling, through provision of training outside companies (e.g., trade unions are becoming increasingly important in supporting the skills development of their members alongside the provision by employers; and in some sectors there are strongly active professional institutions who accredit and provide qualification programmes).

In considering the combination of technical and communication skills that people may possess, it is also important to bear in mind that employees may have 'spiky profiles', that is, individuals may have very different skill profiles within a domain as well as between domains (LLUK, 2007). Thus an individual might have strong technical or communicative expertise, but not both. This further highlights the requirement for 'personalised' learning, in which it is generally more important for an individual learner to be able to coordinate a set of learning goals and learning resources around his or her specific needs (cf. Green *et al*., 2005), rather than the learner having to "fit" him- or her-self into some kind of standard hierarchical framework of skills levels. This phenomenon does not, of course, rule out the need for many employees with homogenous profiles to be supported to develop all aspects of both technical and communicative expertise while working through the different levels of, for example, vocational workplace-based qualifications (e.g., such as those which are well-established in the different sub-sectors of the financial services industry – life insurance, investments, banking). Finally, there are groups of sophisticated technical employees – such as actuaries in pensions companies – who possess great technical expertise but often lack the communication skills necessary to share their expertise with front line customer service employees. Moreover, in the TmL project we found that many

[5] There is evidence from research elsewhere in the ESRC Teaching and Learning Research Programme (TLRP) (Brown, Lauder and Ashton: corporate strategies and the future of skills, involving leading transnational companies and policy-makers from seven countries) that amongst transnational companies there is a 'de-nationalisation' in skill formation strategies, which is shifting the emphasis to individuals to ensure they have the necessary skill sets to have the opportunity to compete for high skilled work (for an early outline of this project, see: http://www.tlrp.org/dspace/retrieve/316/Brown,+Phil++Cardiff+Paper.doc)

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companies seemed to lack effective 'communication channels' for such interactions to occur (Kent *et al*., 2007).

2.2. Training and personalisation in TCS

In the initial discussions in the team about ways to develop TCS, we reviewed materials used for training in the sectors with which we were involved. A key finding from the TmL project, and confirmed in this preliminary field work, is that where technical skills have a mathematical basis there is typically a problem of 'mathematics avoidance' in training and staff development, suggesting a limited capacity for any individual company to consider upskilling in TCS, and the need for sector-based resources to provide a basis for the efforts of companies, which we noted are also typically absent. And, of course, in addition to this, companies do vary enormously in terms of their general commitment to training and the type of training made available to employees.

This motivated our discussion of a **workplace personalised learning environment (WPLE)**, which would have the capability to be effective in a broad range of situations: from companies with well-developed training systems for employees, in which case our focus would need to be on finding ways for the company to incorporate the WPLE within their existing systems of development (and employee incentives, etc); to companies having little or no systematic training, in which case the WPLE would need to support the development of employee self-study, possibly within training provided by a sectoral skills or professional organisation. In addition there would need to be development of a TCS learning culture, for example, by fostering discussion and collaborative learning.

Personalisation has both individual and organisational aspects. A commitment to developing TCS will typically involve companies in significant changes in learning culture, and a WPLE system would need to support organisational as well as individual needs. In the TmL project, we concluded that effective learning of TmL (and by implication here, the learning of TCS) could follow from engagement in *authentic* activities that embedded *actual* work process models made more visible and manipulable through interactive software models or 'technologically-enhanced boundary objects (TEBOs) – see section 4.1 below. We also asserted that determined efforts in iterative co-design that exploited the complementary expertise of employers and educators were needed for the effectiveness and sustainability of TmL upskilling. Thus, we infer that a strong requirement for a WPLE would be that it could support the coordination of the joint design efforts of trainers, managers and technical experts in thinking about new learning materials and activities, possibly delivered through unfamiliar pedagogies. Additionally, since many organisations have rather limited communication channels across communities, a WPLE would need to support their enhancement in terms of the input of expert knowledge to the WPLE and technology-enhanced modes of communication between experts and employees.

3. TCS for careers guidance with financial planning

3.1. Components of TCS for careers guidance with financial planning

We have identified the two main technical components of TCS required by careers practitioners: i) understanding Labour Market Information (LMI), and ii) the need for career guidance to be informed by financial planning. We consider each of these in turn, and in the final sub-section consider some issues of pedagogy for the training of TCS. In Report B include descriptions of prototype Technologically Enhanced Boundary Objects (TEBOs) as tools for learning that represent a first attempt to deal with the learning of TCS in the technical areas of LMI and financial planning.

3.1.1 Labour Market Information (LMI)[6]

Labour Market Information is regarded in government policy as a crucial element in guiding young people and adults towards appropriate jobs and educational opportunities: "people need access to comprehensive and impartial information and advice about local learning and work opportunities and their relevance to the labour market" (DfES, 2004; but see also DfES 2003; 2005). 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, etc. Most recently, the Leitch Review of Skills (2006) emphasised the importance of LMI and recommended the establishment of a new, universal careers service for England that places "labour market focused" advice at its heart (ibid, p. 22)[7].

In addition to policy analyses pointing to the need for more LMI-focused guidance, IAG providers have acknowledged that recent practice has underplayed the importance of LMI. For example, we have looked at the case of "Learndirect Advice", a UK national call-centre-based service offering free, personalised careers advice and guidance for lifelong learning [see the webpage www.learndirect-advice.co.uk/featured/cag/, which overviews the purpose and process of these telephone-based advice interviews]. Learndirect Advice employees have been highly successful in providing information about the range of courses available for prospective learners. However, recently their job roles have been expanded to include the provision of more specific and technical advice, with clients receiving up to 60 minutes of guidance.

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[6] For a comprehensive overview of Labour Market Information in careers guidance (developed by the IER researchers), see www.guidance-research.org/future-trends/

[7] There was previously a shift away from the provision of career guidance for all young people to a concern with the need to support young people in danger of social exclusion: this institutional shift of focus could be seen by the development of Connexions Services and the decline of careers services. The pendulum has, however, swung back, and the House of Lords Science and Technology Committee (2006) concerns are broadly typical even if their example is particular: 'In general, the Science, Technology, Engineering and Mathematics (STEM) careers advice offered in schools appears not to be of sufficient quality, and the Connexions Service is not well adapted to the needs of high achieving students. The government has largely neglected careers advice in Next Steps, and this omission should be remedied at the earliest opportunity' [Science Teaching in Schools, pp.18-19. HL Paper 257. London: The Stationery Office].

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. For example, one set of survey data (LMI) shows that "in 2001, fewer jobs require less than one month for people to learn to do them well (20% in 2001, 27% in 1986)" which is then interpreted in the statement of a trend that "there are indications that jobs are becoming more complex" (DfES, 2004, p. 11).

The statistical nature of quantitative LMI presents significant conceptual challenges to those who need to make interpretations from it. Major barriers to the development of the requisite expertise in TCS relate to the ways in which quantitative LMI is often represented, and the degree of technical understanding required to understand those representations. LMI is often based on large national and regional surveys of companies or households or skills forecasts. The data are sometimes presented in forms intended to be used by people well-versed in statistical techniques, but this is generally not the case for course guidance practitioners. For example, an employment projection may show that there will be growth of new jobs in occupation A and a decline in occupation B. However, other tables, based on demographic data and turnover statistics may show that the replacement demand for occupation B is much greater than occupation A. The net result may be that there will be many more actual job vacancies in the next few years in an occupation in decline than in one that is growing.

A major conceptual issue is that LMI data are historical: they refer to the past, or make projections from the past into the future, based on statistical methodology. Clients of course are only interested in the future; thus it is vital to be able to interpret the validity and limitations of a projection.

> Clients are usually looking for a degree of certainty about the guidance they receive, and maybe the challenge for us is how to convey that we can't deal with certainties, but we can deal with a number of uncertainties at different levels – [in order] to manage uncertainty.
>
> [Participant at project user consultation seminar, 22/01/07].

Statistical data are fundamentally based on the aggregation of samples of individual cases, out of which are calculated statistical numbers (especially, averages and ranges) which summarise the sample data. A major conceptual difficulty is for clients, and the careers practitioner advising them, to perceive their own individual case *in relation to the summarised sample*. This is a general problem known in the educational and psychological literature: there are many strongly-rooted intuitions about being an 'individual' which lead to poor interpretation of statistical information (cf. Shaughnessy, 2007).

The TCS that practitioners need to use LMI effectively requires the ('technical') ability to understand and interpret LMI, combined with the ('communicative') ability to share LMI understandings and interpretations with clients in ways that place that information in a context that has meaning for clients' career decisions and helps them make an action plan. This means that the practitioners have to be able to:

- assist individuals in interpreting and using current labour market information for career planning;
- comprehend and critically evaluate local, regional, national and international labour market information;

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

Hence, we see the case of LMI as both a practically significant and conceptually rich case for developing TCS. Moreover, if we can understand how guidance practitioners engage with developing and using TCS, this may suggest ways in which clients may be helped to develop enhanced skills for career planning generally and through interaction an a WPLE.

3.1.2 Financial planning and career guidance

Our consultations with the IAG community highlighted the expanding role financial planning needs to play in the provision of effective career guidance. One example concerned advice aimed at adults:

> We already have a clear example of where our advisers are being tested – giving advice about career development loans (CDLs) – a financial product which gives a 0% interest loan for the duration of training and then a non-zero rate afterwards. Deciding in the case of a long course whether the interest-free period is worth more than doing a short course – because of the potential to earn money. Also the point at which you start to pay back determines whether the CDL is preferable to a commercial loan. This has come up as an issue for us because we had to write content for our advice website, where you will not see anything which refers to the fact that CDLs may not be a good deal. That's a real financial advice issue.
>
> [Participant at user consultation seminar, 22/01/07].

As well as a need for clients to understand the type of technical issue highlighted above, this needs to be placed in the context of under-developed financial understanding amongst the general population. The HM Treasury report, 'Financial Capability: the Government's long-term approach' (2007), emphasised the importance of the public being able to understand financial services and of how people could be supported in developing their financial understanding[8]. This has implications for possible contexts of use of our approach to developing TCS through linking career and financial planning: introducing a career dimension to financial literacy education could increase the perceived relevance of such programmes to pupils at school or in college.

Some guide ideas for TCS in this context can be drawn from the research of the TmL project in financial services companies. Amongst employees outside the relative few employed in technical departments, we found little secure understanding of the workings of compound interest or loans and 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 for companies to offer training in such knowledge. In some areas of operation this did not matter, where the work was predictable and routine (for example, processing the maturation of an investment bond). However, there were areas of sales and customer services where communication with the customer was core to the work, and the changing patterns of customer

[8] The most interesting suggestion, from our point of view, concerned the idea of 'generic financial advice', which might potentially shift discussion between clients and financial advisers from recommending specific financial products towards a more general discussion of financial planning, and this implies a greater requirement for TCS for both client and adviser. Models of generic financial advice are currently being developed by the Thoresen Review for HM Treasury (Thoresen, 2007).

questions and concerns[9] meant that technical knowledge for the employee was becoming increasingly important. Where it existed, it 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 mathematical relationships and how they relate to the concerns and questions of customers. Our approach to employee development of TmL in our earlier project, was to identify mathematical artefacts in the practice, such as annual valuation statements about a pension, or graphs of loan/mortgage repayments. The next step was then to develop software tools that allowed employees to engage directly with the mathematical models of compound interest and loans, while avoiding the standard mathematical symbolism of algebra. Instead we tried introducing alternative symbolic and visual ways of manipulating and thinking to created technologically-enhanced boundary objects (TEBOs) by using a combination of spreadsheet (Microsoft Excel) modelling and visual tools that we developed.

We found that after engagement with such software and accompanying activities, sales and customer enquiry teams were able to appreciate that the "numbers were not just magic". They were beginning to develop mental models of the products and use these to interpret outputs and respond to customer questions. They thus could move from what we termed 'pseudo-mathematical' labels to seeing how they were interconnected with mathematical structures. It was also evident that enhanced mathematical understanding could help employees engage better with their studies for work-based vocational qualifications that are very important in this sector (since a basic-level qualification is a minimal expectation for permanent employees in most financial companies after several years' service).

Overall the team presented the need for TCS in both financial and career planning and this, together with our approach to how TCS could be developed through the use of TEBOs was endorsed by representatives of guidance and financial services practitioners at the consultation seminars and other events, conducted through the project.

3.2. TCS and pedagogy

The workplace context raises interesting questions for pedagogy to enhance TCS. In the TmL project, and in early phases of this project, we observed that workplace training tended to adopt a largely transmission model of 'delivering' material rather than (as is typical of, for example, 'modern' pedagogies in school-level education) allowing for exploration, questioning and learning from feedback. This is especially the case for mathematical knowledge, where the algebraic formulae that are the standard representation of mathematical procedures are difficult for trainers to handle and tend to invite 'safe' training that ensures that mathematical material will be 'covered' but not necessarily well understood.

As we outlined above, we started from the presumption in the TmL project that technology-enhanced boundary objects (TEBOs) can offer alternative representations for mathematical

[9] Particularly as financial product markets are increasingly competitive, and moreover customers tend to be suspicious of company's activities, and do not take things on trust as they used to before the mis-selling scandals of the 1990s.

knowledge, and can make possible the development of mathematical understanding through activities that are based on exploration, discussion and joint problem-solving around the TEBO. Information Advice and Guidance (IAG) services[10] (and other service industries) provide a particularly receptive context for such training approaches, since the nature of the work is oriented around communication with clients, and is underpinned by expertise in Advanced Communication Skills (ACS)[11], oriented towards "the other person's view of the world" and eliciting this from the other person, and conveying information to the other person in ways that are consistent with their view. In introducing TCS as an additional skill development for this group, it was therefore natural to look to use the same open and learner-centred pedagogical approach, rather than the transmission approach that typifies most training of technical skills.

4. Elements of personalised learning within a WPLE

Our vision is to design a WPLE targeted on the domain of careers guidance and financial planning, which delivers personalised support to learners in response to the unique set of interconnected TCS needs of each individual practitioner. The core technical idea 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 the three key elements which we have identified for personalised learning of TCS. Which would form the core of a WPLE in this area.

4.1. Boundary crossing and 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 artefacts (documents, graphs, computer software) that are used to communicate between communities (Kent *et al*., 2007). Bowker & Star (1999) state that "boundary objects" are "objects that both inhabit several communities of practice and satisfy the informational requirements of each of them", thus making possible productive communication and "boundary crossing" of knowledge. We developed an approach to learning based on the design of symbolic boundary objects, having noted that symbolic information in the form of numbers, tables and graphs was often a poor facilitator of communication across community boundaries. 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 (as mentioned earlier) which were made more visible and manipulable

[10] Such services are provided by various organisations – institutional, local, regional and national – at different levels of the education system: for example, Connexions services for students in the 14 – 19 year old sector; careers services provided (locally and nationally) by universities to their students; and for the general adult population some local adult guidance services or telephone guidance provided by organisations such as LearnDirect.

[11] See, for example, 'The Work of a Career Guidance Practitioner' on the Institute for Careers Guidance website: http://www.icg-uk.org/workinginguidance.html

through interactive software tools. For example, in the TmL research we found a number of workplace situations where knowledge of compound interest was important to practice but employees' knowledge of the financial-mathematical model of compound interest was mostly lacking; we therefore developed tools, and learning activities based on those tools, which attempted to enhance the visibility of the model.

In bringing the idea of boundary objects to the present research on technology-enhanced learning, we see the development of TEBOs as a major part of the research effort to construct a WPLE, alongside other tools, artefacts and learning trails.

4.2. "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, on which they draw in interviews with clients.

We propose to develop the same approach in the WPLE. A comprehensive set of client scenarios would need to be developed to correspond to different guidance issues and the application of relevant LMI data or financial planning methods. A major part of the development effort and an integral part of building the WPLE would be to develop a thorough knowledge of a wide range of scenarios, which would then be the means through which to achieve the contextualised 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 at an organisational level a key step would be to modify and extend the 'basic' set of scenarios provided by the initial system developers in this project (see Scoping Report B).

4.3. Social and collaborative elements

Our proposed development of a WPLE needed to take into consideration the functionalities that are typical of personalised learning environments as currently exist, even though many of these were implemented in formal educational settings. 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 a host of established Web2.0 services which provide different ways to achieve aspects of required functionalities (through the use of 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[12]. Our experience

[12] Although the CETIS team at the University of Bolton point out that it is possible to have a PL toolkit from which choices can be made for a particular user, whereby the PLE comprises an environment of services which are accessed through a PL toolkit (Johnson *et al*., 2006).

(in developing and operating the National Guidance Research Forum) in delivering web-based support for continuing professional development suggests that a *small* sub set of the wide range of possible services can be sufficient to keep learners 'on task', where above all the requirement is to offer support for learning and development without distracting the learner. In this respect there is a distinct difference between how Web2.0 services are typically offered within formal educational institutions – there the intention is often to utilise services that "may not necessarily be regarded as explicitly 'educational', [as] they present a potential for an effective personal organisation which is at the very least beneficial to institutionalised learning, and in some cases of direct benefit to it" (CETIS, 2007).

In our context, the key feature of Web2.0 services is the way that they allow the experience of practitioners to be drawn on, for example, offering the ability to upload to the WPLE contextualised examples of what they did in practice and how they used WPLE resources in ways that were meaningful to their clients. Being able to create & personalise changes the feel of a site from one where users are essentially encouraged to engage in 'good practice' created by experts elsewhere, to one where active engagement in the co-construction of 'good practice' is validated. It is also important to note that direct participation is not the only indication of learning. Evidence from Warwick's current National Guidance Research Forum site shows that many people are **invisible learners**; people who find the site useful for their own learning and development, yet do not make contributions and hence appear invisible on the site itself.[13]

Web2.0 technologies suggest the possibility of an integrated approach to content representation and social networking, and past practitioner experience can be drawn on in an integrated way that records learning. By this means the experience of learners' attempts at implementation as well as their learning experiences become available as resources for other learners. The development of TCS is therefore firmly grounded in a focus on professional practice. The WPLE can therefore act as a means of integrating day-to-day practice with learning engagement, through a process of individual and collective reflection and review.

We investigated the possibility of using a wide range of Web2.0 tools, but one important task was to investigate what was the *minimal set* of tools required for us to achieve our purposes of transforming approaches to the learning and development of TCS. We did not take for granted that the most prevalent Web2.0 tools (offering various forms of chat and messaging, content aggregation, tagging and social bookmarking) would be relevant to the WPLE. For most practitioners interested in developing their TCS the most important facilities were likely to be those that help them to plan, develop and reflect upon their learning, choose development and implementation experiences, and have the facility to adapt, or in some cases develop, learning trails, TEBOs and related learning resources for themselves.

Hence the following were regarded as essential requirements for the intended purposes of the WPLE:

- user spaces for planning, reflection and sharing resources;
- personal development planning and related tools and services;

[13] That the designers are aware of this comes from the scores of face to face sessions with practitioners about how to make best use of LMI, where the practitioners regularly report that they use the NGRF site both as a source of information and professional development.

- "e-portfolios" (used as a tool for self-reflection but could also be used as a tool for the collective development of organisational effectiveness);
- spaces for informal and goal-directed discussions;
- individual and group-based learning modes;
- the ability to create user-generated content (both in relation to provision of examples of effective implementation and in the co-design and adaptation of TEBOs).

4.4. Modelling of the user in a personalised system

The project team also investigated whether it was possible to go beyond the functionalities associated with a typical personalised learning environment, in which the user may 'personalises' their use of the system (for example, by creating personal libraries of resources, or reflective diaries / blogs) 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; Magoulas & Chen, 2006). This type of approach could lead to 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 could interact with the user 'intelligently' by utilising user-related information, in order to adapt the application's contents and presentation to the user needs, goals and interests. To this end, an understanding of the users, and their cognitive characteristics, goals and domain knowledge would be needed. This understanding could be achieved either through a 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 model is hidden from the user. Both approaches are relevant to the functionalities intended for the WPLE.

The role of adaptivity in the WPLE is described further in Report B (Section 5).

5. User feedback to the project's proposals

Users were consulted about our developing ideas throughout the project. However, towards the end of the project we carried out two more formal consultation events with careers guidance practitioners to discuss the more mature ideas we had developed for the WPLE, and also to test informally several prototype learning tools and activities that we developed. These involved four interviews with senior guidance practitioners (a deputy manager of a university careers service, a practitioner- researcher and two university-based trainers), and a focus group meeting with eight students on a postgraduate-level guidance training programme. Their reactions to the prototypes are reported further in Report B. Here we present general feedback to our proposals.

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 one aspect of the problem of understanding and communicating statistically-expressed LMI as concerning helping clients "to find themselves in the data":

> In careers guidance, the primary duty is to put the client at the centre, so it is exactly a case of 'finding the me in the mass of data'. So if you can show this tool as something that allows the adviser to strip through the data and find the me, the client, that is an immediate win – people will buy into that.

Feedback was more mixed on the merging of financial planning with guidance. The students all reacted warily, suggesting that it is a topic that usually leads to a client expectation of directive advice, which guidance principles aim to avoid. Along similar lines, one experienced practitioner commented:

> It does come up, 'should I spend my redundancy pay on such and such training?' As people get older their lives get more complex, and financial planning for me is one of those other things that makes a case complex. I feel no adviser will go down the line of openly giving financial advice – in the same way as running a mile from medical diagnosis, which can occur in redundancy counselling, where you encounter mental health problems or other health problems- so you acknowledge they are bringing that to the table, and get them to reflect on the impact it has on their career choices, but your action points would be something like – 'it seems there are big implications for your financial status, which means talking these through with your bank or other financial adviser'. So it's picked up and explored but no directive advice is given.

There was, however, positive support for the idea that TCS for financial planning could play an important implicit role in enhancing practitioner's abilities:

> I see this as something great to know about in order to ask better questions – not giving answers. Like if someone is going into self-employment, to know enough to make sure they are aware of dealing with VAT, etc. So it's not financial literacy, maybe numerical literacy, to know what questions to ask to ensure that a client is appropriately signposted and appropriately reflective. If you ask a question and the client doesn't know what you are talking about then that suggests they are not prepared for a certain career step.

What also emerged from comments was a sense that if financial planning was going to be a new feature of practice then it would need special training:

> Advisers would be wary of getting into a situation of being expected to give some kind of financial advice. A similar situation I have been in was working in a university with lots of international students who frequently asked about issues with their immigration status, work permits and so on. We refused to touch that – and in the end the executive decision was to formally train a few advisers in providing such advice. There may be a similar issue with financial planning. There is pressure for advisers to work more holistically, but there is not necessarily the training and support that advisers need.

Interestingly, this chimed with a comment at the January user seminar, where it was suggested that careers guidance should learn from the regulated structure of advice in UK financial services, where different levels of authorisation to provide indirect or direct advice are tied to levels of employee qualification.

6. Conclusions

Within the IAG sector (as well as in other sectors) there is widespread recognition that there are substantive skills gaps linked to TCS that have major implications for employees, their clients and the economy as a whole. The sector faces challenging issues of learning, development and performance and there is, at present, no mechanism whereby current arrangements can do much other than make marginal, rather than systemic, changes. In this setting, we believe our advocated approach of using a socially-oriented and adaptive model for the development of TCS could lead to substantive and measurable improvements in the quality of advice given in adult guidance. We have outlined the case of a 'skills gap' for TCS in the particular context of careers guidance practitioners, in relation to the combined knowledge domains of LMI and financial planning.

The extended use of LMI has been identified in national guidance policy as a high priority issue, yet at present only a very small proportion of practitioners fully understand LMI and only a few organisations have strategies to leverage that knowledge[14]. The knowledge learned by one individual practitioner about LMI interpretation is also not easily passed on to others, resulting in sub-optimal levels of organisational knowledge in this area. Furthermore, knowledge sources that are available are either disconnected or, even where they are brought together, as for example in the Future Trends section of the National Guidance Research Forum (NGRF)[15], they remain as valuable knowledge assets that are under-used by individuals and communities. Connections to others working with these knowledge assets are especially important, since innovative ideas often come from larger networks associated with careers guidance practice within which the individuals and organisations operate.

All the issues in the preceding paragraph are mirrored in relation to financial planning; financial literacy is a major national concern and issues around its development have been well documented in, for example, the TmL project. Additionally, there is widespread mathematics avoidance amongst the public in general, which points to the importance of new ways of support that directly 'connect' to users. Finally, for both domains, the process of how to support the transition of emerging topics into mature knowledge that aligns with practitioner practice and organisational goals is not well understood or supported. In particular, there is an urgent need for processes that simultaneously motivate practitioners to make contributions to the development and application of practical knowledge, and guide these contributions towards organisational (and policy) goals linked to guidance being more expressly LMI-focused and explicitly taking account of financial planning.

The learning of TCS is an inherently social and collaborative activity, whereby there is knowledge flow across different interlinked individual learning processes. Thus we have

[14] For example, all the sector skills councils (SSCs) will have responsibilities for the development of TCS by employees across the UK as part of their sector skill agreements. To be able to offer technology-enhanced learning as a means to achieve this would be a considerable boon, but SSCs and other stakeholders lack the capacity to do this. Hence if this project delivers exemplar materials in a few sectors, but also a framework of how to do this in other settings and support for building the capacity of sector skills councils to achieve this that would be a major achievement.

[15] See http://www.guidance-research.org/future-trends/

sketched the design of a WPLE which would have the flexibility to be implemented in the different types of small and large organisations involved in careers guidance, and to have the functionality to learn from its users and to adapt to the situation, through community-driven knowledge sharing and learning.

The development of a WPLE entails an interdisciplinary research effort between mathematics educators, computer scientists and academic guidance specialists. Moreover, the TEBOs which we have identified as core tools for technical learning will require extensive co-development work with the end users of the WPLE, namely guidance practitioners. For researchers to understand the context domain and to iteratively develop TEBOs and learning trails requires drawing on the depth of professional experience of practitioners. Such knowledge is often embedded in the context of practice and will be only partly decontextualised when expressed within the prototype TEBOs. In any case, such TEBO development would represent only an intermediate stage of knowledge construction, as the subsequent stages would involve knowledge sharing and recontextualisation of approaches to the utilisation of TCS in work with clients.

The most encouraging outcome of this TEL development project is that it generated a consensus between policy actors, practitioners, trainers and researchers on a strategy for development and design of a WPLE to support the development of TCS for guidance practitioners.[16] With support of these users we are at the time of writing (July 2007) currently taking this work further in developing a prototype system and have submitted an application to the second round of the TLRP TEL 2 research funding competition. We will site this within the learning community for guidance practitioners we have previously developed (NGRF) (Brown *et al*., 2005). There is still a formidable multi-disciplinary learning challenge, i.e. whether we can support this community to move from focusing upon best practice and knowledge stewarding (organising and managing a body of knowledge concerning TCS in career and financial planning) to becoming an innovation community – that is, one that can create breakthrough ideas, knowledge and practices (Archibald & McDermott, 2006). An innovation community should be emergent, adaptive and lead to fundamental changes in work practices: the embedding of a more Labour Market and financial planning focused approach to guidance, which in turn requires a step change in the TCS of guidance practitioners. This is where TEBOs will be critical: if guidance practitioners are able to visualise, analyse and utilise labour market information and ideas of finance in new ways, then the guidance process they offer for their clients could indeed be transformed. However, even when the prototype learning system is operational it will be important to look beyond just influencing those practitioners directly involved in any subsequent work and to make sure there will also be a strategy to engage policy and practice communities more widely at both local and

[16] During the development project the research team had discussions with members of HM Treasury, DfES, SSDA, sector skills councils, Learning and Skills Council, UfI LearnDirect and Institute for Career Guidance. The DfES and LSC have since been restructured (June 2007), but our contacts will continue to be involved in this area in DIUS and the restructured LSC. This consensus is particularly important given the proposed move to a universal approach to adult guidance with a stronger labour market focus. This means that the development of TCS has moved from a desirable requirement to a fundamental component in the development of practitioner expertise.

national levels and to develop an innovation community.[17] The direct community involvement in current and proposed future work shows the extent to which they have embraced the idea that TEL can play a key role in support for the development of TCS, which in turn can play a part in changing the learning, development and practice in guidance.

[17] Again this work has already started with the set up of an 'Innovation Group' to consider how learning, development and practice of career guidance may be transformed. Additionally, any future work will also involve working with national practitioner bodies such as the ICG and careers guidance training providers to ensure not only take-up and usage within current practice but also that this approach is embedded within future training provision. Hence careers guidance training providers based at the Universities of East London; Glamorgan; Strathclyde and Ulster have all agreed to be involved in subsequent work. It is particularly important to get representation from all parts of the UK as the guidance systems vary significantly between jurisdictions.

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