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

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SCOPING REPORT B

Requirements description and specification of a career guidance and financial planning 'Workplace Personalised Learning Environment' system

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

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Contents

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1. Introduction

Scoping Report A[1] considered the nature of technical communicative skills (TCS) and the extent to which these skills may be developed through the use of technologically-enhanced learning (TEL), and the ways in which a TEL system can deliver a personalised learning experience. Those issues, however, were treated at a general level, whereas in this report consideration will be given to how such a system might be operationalised[2], with a particular focus upon the requirements needed for the development of TCS and how an outline specification could be developed for a Workplace Personal Learning Environment (WPLE), in the particular context of career guidance and financial planning.

One challenge for the interdisciplinary research team was to develop a shared framework and methodology. In this endeavour, we found the use of the joint notions of **boundary object** and **boundary crossing** to be helpful (see Report A, Section 4.1). The ideas of boundary crossing and tool mediation (Tuomi-Gröhn & Engeström, 2003; Kaptelinin & Miettinen 2005) and situated learning with a close alignment to the importance of a focus upon practice (Brown *et al*., 1989; Hall, 1996) coupled with the earlier work on the Techno-mathematical Literacies project (Kent *et al*., 2007) informed our considerations of the role of symbolic boundary objects in elaborating the nature of TCS in different contexts, and their enhancements through technology into TEBOs.

In thinking about TCS we emphasise our specific concern to make visible the epistemological role of **symbolic** boundary objects in situations in which people from different communities use common artefacts in communication. A fruitful approach to choosing ways to develop particular boundary objects is to focus on what Onstenk (1997) defines as **core problems**: the problems and dilemmas that are central to the practice of an occupation that have significance both for individual and organisational performance — in this case the problems associated with providing advice that has both financial and career planning aspects. One method this development project used was therefore to engage in a dialogue with guidance practitioners about common scenarios involving quantitative LMI or financial planning that would inform the development of the WPLE demonstrator, which included prototype TEBOs[3]. WE envisage TEBOs as key components of the proposed WPLE. to help practitioners develop their TCS in order to enhance their understanding of and subsequent use of (quantitative) Labour Market Information (LMI) and financial planning in a variety of guidance settings.

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[1] "The nature of technical communicative skills and an outline of a career guidance and financial planning workplace personalised learning environment".

[2] One of the aims of this development project was to produce a specification of the Workplace Personalised Learning Environment as the descriptive basis for the future implementation of such a system. This introduction maps out the reasons for the shift from a WPLE applicable to separate guidance and financial services contexts to a single integrated Career and Financial Planning WPLE. It was still possible to produce a specification of the proposed WPLE and this is developed in the later sections of this report. A specification written from both a user and a computational perspective offers a sound basis for a future system implementation.

[3] The consultation processes made use of methods of progressive inquiry (Hakkarainen and Muukonen, 1999).

The development of WPLE was therefore informed by a consideration of the following issues:

- Importance of developing methods and strategies for co-design with users
- Need for technical tools embedded in TEBOs to help people understand the models and ideas which are part of LMI and financial planning
- Need for a more open pedagogy (than is typical of much existing technology-enhanced learning, *and* existing workplace training practice)
- A system in which TEBOs are configurable by end-users (practitioners) and by guidance trainers to be used in multiple ways
- Need to build an understanding of how TEBOs may be used in ways that are empowering for practitioners, and ultimately for clients too.

Coupled with another set of issues concerned with fostering TCS:

- Need for time for people to interact, reflect, use concepts etc.
- Trying to reach a stage where practitioners have justifiable confidence in the claims they make and can exercise judgement about the value of information when faced with unfamiliar LMI
- Choosing between a range of possible use-contexts
- Deciding how to employ support from communication and discussion tools
- Developing and transmitting Labour Market intelligence or financial guidance
- Preconfiguring certain ways of thinking through use of scenarios; discussions can point into and lead from scenarios.

The above sets of issues provided a clear steer to the type of investigations that would be needed to investigate how the WPLE might be used to support the learning and development of TCS of guidance practitioners. There are also broader questions about the overall design of the WPLE and how users might interact with the system in practice that will be dealt with later in the report, but first we turn our attention to how practitioners might use TEBOs in order to develop their technical communicative skills.

2. Examples of developing TCS through the use of TEBOs

The project team developed two prototype TEBOs in order to explore their potential uses in the context of career guidance and financial planning. We emphasise that the particular choices of software (TinkerPlots and spreadsheet) that were used are not those that would actually be used in a WPLE. Rather they were existing software applications that were easily accessible to us and allowed us to convey to users what we were seeking to achieve. That is, the way we used the software represented the characteristics of the TEBO tools we felt to be most important for creating tools with which conceptual learning could be achieved.[4] So what is of most interest here is the process of how practitioners might engage with TEBOs and how this informed the design of the TEBO and the design of an overall learning system (WPLE) and how this might be used in practice. The particular examples chosen are therefore carriers of the process rather than prospective tools.

The two prototype TEBOs were presented for user feedback as follows:

- Interview / demonstration of TEBOs with Lucy Marris, an experienced practitioner now working on the development of LMI learning resources at IER.
- Interview / demonstration with deputy manager of a university careers service ('Russell Group'), responsible for quality assurance and professional development of the team of advisers.
- Focus group discussion and hands-on trial of the TinkerPlots TEBO with 8 students from a post-graduate training course for careers guidance, at a "post-92" university.

The duration of each of these sessions was approximately two hours.

The two interviews were used partly as preparatory discussions for the final session with students, to understand the likely motivations and interests of the students, and what they might be capable of doing with the software in the time available.

Each prototype TEBO will be described together with practitioner feedback before reaching a conclusion about how practitioners might use TEBOs in order to develop their technical communicative skills.

2.1 Example 1: Understanding LMI about salaries

This example arose from scenarios of client questions and issues collected by the research team from guidance practitioners. The intention was to show how useful it was if a practitioner was informed about LMI and to raise the question of whether the practitioner felt his or her TCS were sufficiently well-developed to produce an appropriate response. A typical scenario was as follows:

> I am 32 years old 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 decided I wanted a career change and

[4] The whole point of this approach is to create visually compelling symbolic boundary objects, but a full implementation of this approach was beyond the scope of this small development project. However, an idea of the character and quality of the resources that will be developed can be gauged from previous work on the TmL project: see http://www.ioe.ac.uk/tlrp/technomaths/tools_spc.html

> that I also needed to obtain better qualifications. So I have recently obtained a 2:1 in Business Studies by distance learning from DeMontfort 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). As I took out a career development loan to follow my postgraduate study, I need to find a job as soon as possible 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 to 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 carry through to all potential jobs and would like some advice.

The strength of this type of scenario is that it highlights a number of important career guidance and LMI issues that inter-relate with financial planning. For the purposes of this example, we will focus upon one of the more straightforward issues: if a graduate already has considerable work experience, at what level of salary might he or she typically expect to start if starting salaries are presented as a range? Besides experience, salary expectations may vary according to qualifications achieved and spatial considerations, linked to intention to seek work in a particular location. There is a variety of LMI related to salaries for particular types of work, however it is generally presented in a summarised form of average salary in a certain job type, or company type, or geographical location. There is thus a disjuncture between the individual perspective of the clients' questions ("will I get a job doing X?"; "is it worth my while to do X?") and the summarised nature of the LMI data (averaged across a sample population). As expressed by one of our consulted users, there is a constant need by clients to "find the *me* in the data".

One way of dealing with this challenge, suggested by research in the statistics education literature at school level, is to use visual/manipulative statistical software which makes evident the relationships between individual data points in a sample (that represent a real person) and the statistical measures which summarise across a whole sample of data points (people). We therefore used a specially designed statistics program, called TinkerPlots[5], to set up prototype learning activities which made use of real LMI data in order to provide an entry into discussion about the different ways it might be possible to develop TCS for guidance practitioners. The important characteristics of TinkerPlots are that statistical manipulation is carried out via mouse manipulation of graphical data points, rather than a textual language, and that the attributes of individual data points are always available for inspection and manipulation.

The intention is that, following the necessary development work, a technologically enhanced boundary object (TEBO) could be a means for practitioners to learn about some of the mathematical-statistical concepts underlying LMI data. Thanks to the power of the representation it could also be used to discuss careers options with clients.

In order to create a 'close to practice' context for discussions with the practitioners and to populate TinkerPlots with relevant data, we created a data set drawn from data in the Labour Force Survey, a large questionnaire-based survey conducted by the Government National Statistics Office, for which the data is published in full and is in the public domain[6]. This data was very large (about 120,000 cases in the set, and several hundred variables per case) and

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[5] See (Konold & Miller, 2005): www.keypress.com/TinkerPlots

[6] Available from the ESRC Economic and Social Data Service. We used the data set from the 4th quarter of 2006: http://www.esds.ac.uk/findingData/snDescription.asp?sn=5616

required a fair amount of editing to produce a small and relevant set of variables (also we found that many of the variable entries in which we were interested were blank, and so had to filter the data to produce a usable sample; we used a combination of Microsoft Excel and the specialist statistical software SPSS for this). There were 2677 cases in the final data set that we used to test this approach to developing the TCS of guidance practitioners.

One issue for future research is that many surveys of individuals and companies that are used as the basis for readily-available LMI in the UK do not publish any source data on the grounds of confidentiality.[7] However, access to the source data about individual cases (of people or companies) may help practitioners to gain a sense of how the data is aggregated and can be broken down in different ways. Hence the future development of a WPLE would need to allocate sufficient time and resource to the visualisation and representation of data in different ways within any TEBO. Thus to stay with this particular example, the creation of appropriate data sets (involving negotiating access to data sources, editing and simplification of raw data, and modification to assure anonymity of sources) would in itself be a significant challenge.

Figure 1 gives a picture of the opening screen shot of this TinkerPlots example.

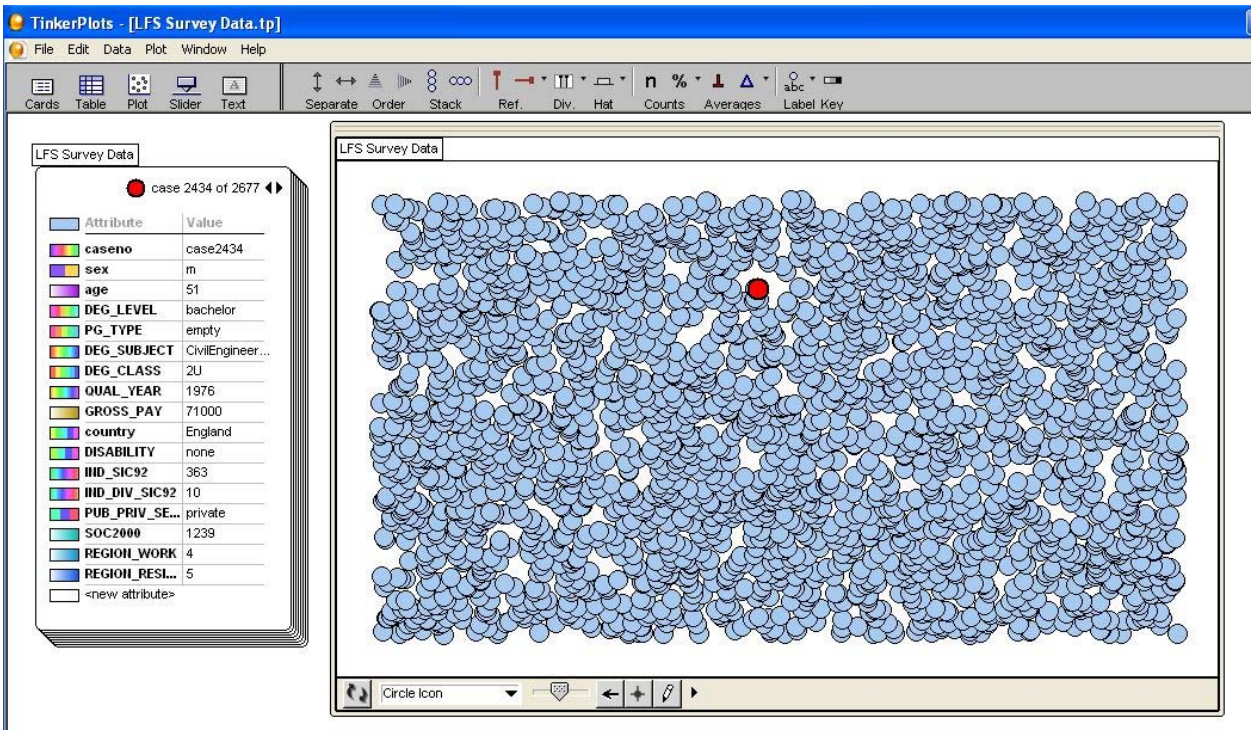

Figure 1: Opening screen of TinkerPlots for analysing the Labour Force Survey data. On the left are the "stack" of data cards, on the right a visualisation of this data as a set of unordered "buttons" scattered on a tabletop (two-dimensional area). At any stage of using TinkerPlots, it is possible to see the precise data corresponding to any button simply by clicking on it.

[7] Interestingly, even in countries such as the USA that do have much more detailed LMI available, partly because of the Freedom of Information Act, and publish this information at local, state and national level, there is still a TCS issue, because the information may have considerable technical and statistical information embedded within it: see, for example, the information produced by the Employ Florida Communication Consortium (EFCC) which is fairly comprehensive but also fairly dense (in talking about rates of growth of jobs and replacement demand) https://www.employflorida.com/occprofiledata.asp?session=occdetail&geo=1201000000

We prepared a small set of activities (reproduced in Appendix A) to assess how guidance practitioners would engage with the TinkerPlots software interface, and to see how they connected a set of data about graduate salaries with thinking about client scenarios. The data (shown in figure 1 above) available for each individual includes the gross annual earnings (GROSS_PAY) of a sample of graduates in relation to variables about educational background (level and subject of degree), type of work done (according to the 'SOC 2000' classification), type of company worked for (according to the 'SI C92' classification), and location of work. Figure 2 gives an illustration of gross pay plotted against type of work undertaken. The feedback on these trials is reported in Section 10 of this report. What is important here, however, is that this example has shown that it should be possible to create TEBOs that transform the way practitioners visualise, manipulate and represent different types of LMI.

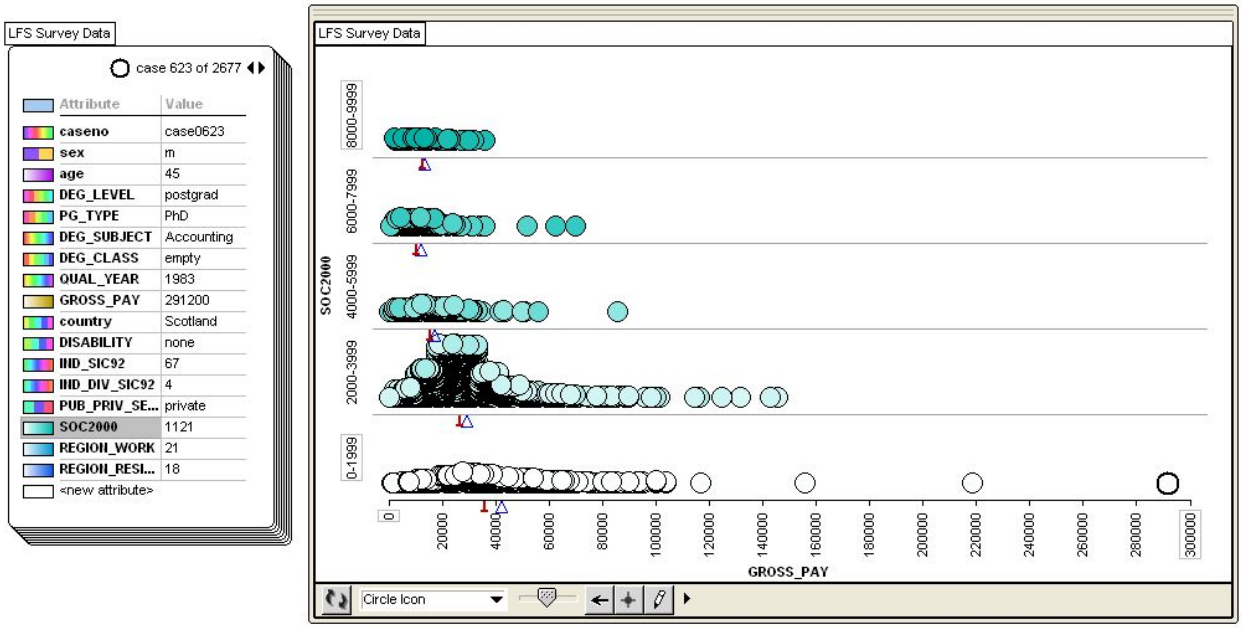

Figure 2: an organisation of the data into job types and salary distribution of each sub-sample (using the 'SOC 2000' scheme in which numbers starting with 1 denote senior skilled managers, ranging downward in skill level to level 9 which represents manual workers). The triangles mark the average value of salary for each sub-set of the data, and the inverted T's mark the median values. The data card shows the case of the highest-earning individual (£291,200) in the whole sample, a male, 45 year old senior manager in a finance company.

2.2 Practitioner Response to Example 1: Understanding LMI about salaries

The questions/scenarios used when this TEBO was discussed with eight trainee practitioners are given in Appendix A. The eight students worked in two groups of 4 with two laptop computers, for approximately 25 minutes (their interactions were recorded with screen capture software and simultaneous audio, for later analysis by the researchers). Both groups made quick progress in learning the basic moves for TinkerPlots, and the researchers helped the students to carry out any actions which they could not work out how to do.

All the feedback on this TEBO confirmed our design hypothesis in this example that 'seeing the individual' in the statistics is crucial, and the TinkerPlots visual-manipulative interface worked very well in making this possible. Participants also perceived well the intention of the TEBO as a tool into which different data sets could be introduced. The students commented, however, on

the lack of reliable local LMI, which is important to guidance with young people especially, compared with the existence of regional/national LMI. They felt that such LMI was much more readily usable with university students than with young people. One example that came up in discussion was the construction industry – the LMI says that there are huge demand for new workers, but young people in the neighbourhood of the university did not find it easy to access these jobs).

2.3 Example 2: Understanding loans (career development loans)

Example 2 was a less developed example, and the choice of software, a spreadsheet, less close to the characteristics we would ultimately seek for an implemented TEBO. Whilst the spreadsheet interface is somewhat clumsy, there is the core ability to create symbolic models of situations, and to do 'what-if' explorations of different model parameters. We felt that such exploration is central to learning how financial products work and how to incorporate models of products into financial planning for clients. We based this approach on successful previous research on financial modelling with spreadsheets in financial services workplaces (cf. Kent *et al*., 2007).

Based on a suggestion from the user consultation seminar in January 2007, we decided to develop a spreadsheet model of how a Career Development Loan (CDL) is paid back compared with a conventional bank loan. CDLs can be used to pay for study fees and living expenses during study. They have the advantage of 0% interest during the period of study, but repayment on a commercial basis is expected as soon as study finishes, and the rate of interest is relatively high (12.9% per annum). Thus although the CDL is Government-backed and is promoted as beneficial for learners, it may not be a cheaper alternative to a conventional bank loan depending on the duration of the course and whether the student is able to access cheaper loan rates than the CDL (a mature student with substantial assets could readily obtain loans at rates of around 7% per annum).

An important point about the spreadsheet is that the mathematical model and calculation involved is very simple to express in a spreadsheet (unlike in algebraic symbols), and is moreover a general model that can be applied to any kind of loan. Thus there is a general point to the mathematical learning with this prototype, and this is a desired characteristic of any TEBO: that a generalised understanding develops by working across sets of specific situations. It seems this is a tendency which guidance practitioners already develop, in that they have repertoires of common client scenarios, which map to underlying key guidance issues, and these are applied to make sense of a new client case and to make judgements about the client's essential concerns, which can lead to appropriate guidance being offered within the time constraints of short interviews.

2.4 Practitioner Response to Example 2: Understanding loans

This prototype TEBO was only demonstrated in the three sessions, as it was not sufficiently developed to allow hands-on exploration of the data. The one major difference in response between the trainee practitioners and the more experienced interviewees concerned this TEBO, was that the experienced users saw financial planning as "something to know about in order to ask better questions – not giving answers", whereas the trainee practitioners perceived financial questions as a 'no go' area for career guidance practitioners.

The two interviewees could follow the use of the spreadsheet model and the exploration of different 'what if' cases and appreciated the conceptual issues about the career development loan

– that it is government-backed was therefore presented as a ‘good deal’, yet it may not be a good deal depending on personal circumstances.

2.5 Conclusion

It was clear from the user trials with the prototype TEBOs that practitioners could see how they might use them to develop their technical communicative skills. However, practitioners needed to be convinced of the value of combining career and financial planning – that is, much current guidance training and practice downplays the significance of the need to examine LMI too closely or to investigate the financial consequences of different career and development choices. This meant that while well-designed TEBOs would be a necessary component of any attempt to develop the TCS of guidance practitioners, they would not be sufficient. The overall design of the learning system (WPLE) would be centrally important, and in particular the question of how practitioners could be encouraged to see that a different approach to practice might help improve their practice and outcomes for clients, how they might be supported in developing their practice subsequently and how discussion and social networking in the WPLE could support this process. So future development work with TEBOs would need to address how individual practitioners interact with the learning resources of the envisaged WPLE as a whole, as well as meeting the following challenges:

- Identify the key set of TEBOs needed to support the development of TCS for guidance practitioners (understanding LMI and financial modelling/planning);
- Identify the *conceptual* challenges in interpreting the output of TEBOs: graphs; labour market predictions; charts; employment data; financial models etc.;
- Identify the connected *communicative* challenges in identifying the merits and disadvantages of different choices according to different personal needs, and communicating personalised advice based on LMI and financial planning?
- Identify the appropriate pedagogic scenarios for the use of TEBOs in learning TCS within a personalised/adaptive learning system;
- Support practitioners in how to visualise, analyse and utilise labour market information in new ways in the guidance process they offer to their clients.

For the **technical design and programming of the set of TEBOs**, the user trials reinforced the need for practitioners to be involved in all stages of an iterative design process in order to understand the context of user. The software basis for the TEBOs will also be an important element in their attractiveness to practitioners, and it is likely that one of the ‘rich internet application’ software platforms, such as Adobe Flex or Java, will be used in future development work.

Overall the work with the prototype TEBOs showed that it should be possible to exploit the rich potential of TEL systems to support learning through the visualisation, consolidation, representation and transformation of knowledge. The set of BOs and TEBOs to be developed in future will be theoretically-informed, more comprehensive and visually compelling in line with previous research. For example, the value of multiple representations of information, including dynamic visualisations of data and relationships has been well documented, along with a recognition of the importance of a sound underpinning model of the basis for conceptual understanding (Ainsworth & Th Loizou, 2003; Hegarty, 2004; Lowe, 2003, 2004; Ploetzner & Lowe, 2004; Schnotz, 2002; Chandler, 2004; van Someren *et al*., 1998; Narayanan & Hegarty, 2002).

3. Aims of the WPLE system

The overall aim of the WPLE system will be to support the development of Technical-Communicative Skills (TCS) in career and financial planning, with the potential for it to be extended to other domains of application of TCS.

The learning context is to support guidance practitioners in developing the ability to interpret and communicate statistical and other technical information and to combine this with appropriate careers and financial planning and guidance for their clients. Guidance practitioners need to enhance their ability to interpret and communicate information about labour markers and issues around financial planning, and to incorporate this in their guidance. Guidance practitioners are the focal set of users of our system. These are the 'learners' in the system, although their clients may also be developing TCS knowledge as they interact with the practitioners.

We have outlined in Section 2 the idea of TEBOs. In the broader context, key objectives are:

i) the development of compelling, technology-enhanced boundary objects (TEBOs) – problematic and conceptual – as components which are functional within the organisational and technical environments of the system, to provide a means of exploration-oriented learning in a broad range of learning contexts and

ii) these TEBOs and other components of the WPLE will be standards-based (exporting web service interfaces and using standard metadata where possible), and will thus have the potential to be reusable in other learning contexts

In a future research project that would aim to implement the WPLE system, the research team would co-design the learning elements with practitioners and practitioner stakeholders, with the aim of the design role eventually being handed over to stakeholders in different career guidance sectors and contexts. In organisations where there are designated trainers, the practitioner stakeholders are likely to include these trainers.

Another potential focal set of stakeholders and co-designers of the system are technical experts in Labour Market Information (LMI), who may have a 'spiky profile' where technical knowledge is the spike. Their knowledge of common client questions would be incorporated into the system via the designers, for subsequent re-use as learning resources by practitioners.

The original project proposal distinguished three perspectives: the **user perspective** (what users need and the functionality this implies), the **system perspective** (what the system needs to provide viewed by a potential system developer) and the **computational perspective** (detailed technical requirements). As expected, our work in this 6-month development project has proceeded in all three dimensions collaboratively, involving all the project partners. We aimed first to develop and refine users' expectations of the envisaged system – this activity began at the outset of the project and has been intensively pursued throughout the 6 months. Once we had identified the main learning resources, categories of users, and use cases of the system (about 4 months into the project), we then proceeded to identify the set of tools and the system architecture that would need to be developed in order to provide the envisaged functionality. Due to the challenges involved in developing this new interdisciplinary research initiative in supporting TCS skills, and the team's decision to pursue first the user and then the system perspective, there has been less time than was originally planned to work on the details of the technical requirements: for example, to design metadata schemas, to derive detailed functional

requirements with respect to metadata generation from existing and new learning materials, to define the specific attributes of learner models for learners developing their TCS skills, and to design in detail the adaptation and personalisation features of the envisaged system. These issues are all discussed to some extent in the ensuing sections of this report, but they do remain open research challenges.

The following sections describe:

- the key learning resources that would be provided by the system, from primarily a user perspective;
- the main tools to be provided by the system, from primarily a system and computational perspective;
- the main categories of users (user and system perspective);
- the main use cases of the system (user perspective);
- a usage scenario illustrating how users may interact with the system to accomplish their learning, design, communication and information seeking goals (user perspective);
- the envisaged system architecture, and the components and services it comprises (system and computational perspective);
- a demonstrator of the envisaged system (user perspective).

4. Key learning resources

Key learning resources that will be provided by the system are as follows:

- **Scenarios:** a textual representation of a client situation (real or synthetic), which raises challenges for guidance, and includes implications for courses of action (learning) for guidance practitioners in this context. Scenarios are categorised according to 'key concepts' – see below.
- **Key Concepts:** these are one aspect of the metadata of the system, and they will be key dimensions for categorising scenarios, learning trails and interaction trails – see below. Examples of key concepts are debt, future salary potential or aspiration, and career change.
- **Technology-enhanced Boundary Objects (TEBOs**): these are symbolic boundary objects relating to a specific mathematical-technical concept, which are 'dynamic' in the sense that learners can interact with, manipulate, reconfigure and integrate them, rather than just view them. Reconfiguration and integration facilities may be needed, for example, to address particular client needs, rather than single general conceptual challenges. TEBOs have a strong, visually appealing aspect. They could be regarded as executable programs whose activity can be monitored/logged by the system. They will be co-designed by the research team, working together with content authors, experts and practitioners.
- **Learning materials:** in contrast to TEBOs, these can be viewed and browsed by users of the system, but are not dynamic in the sense that a user cannot change their presentation of information while interacting with them. Examples are video and audio clips, PowerPoint presentations and other documents. Again, however, it would be possible for the system to log when users are invoking such a resource (and how long for, in what context etc.) but the system would not monitor and log how users are interacting with it.
- **Case studies:** these are examples of practitioner/client interactions (possibly textual, audio or audio/visual), authored or assembled by designers and content authors, and containing examples of good and less good practice.
- **Learning trails:** these are a sequence of invocations of TEBOs, learning materials, case studies, communication tools, information gathering/filtering tools (see below for a description of these tools) and other external tools, aimed towards achieving a particular learning goal or goals. Learning trails will be specified by designers, learners or collaboratively. They may possibly be semi-automatically generated by the system itself, from its knowledge of the learning resources, the learners and their learning goals. The system will monitor and log users' interaction and progression through learning trails.
- **Interaction trail**: these are structurally similar to learning trails, but their purpose is to fulfil a particular client interaction goal or goals.
- **Data sets:** these are externally available data sets[8], which will be accessible from TEBOs, case studies, and learning and interaction trails.

[8] For example, drawn from the future trends section of the National Guidance Research Forum: see http://www.guidance-research.org/future-trends/

- **Metadata:** all of the above learning resources, and also all users of the system, will have information recorded by the system about them, that is necessary for carrying out the system's functions. This information will conform to a set of metadata schemas, and the detailed design of these schemas remains an open research question. Where appropriate, we envisage that existing metadata standards for describing learning objects and learners would be used and extended as necessary. Appendix B of this report lists the main relevant metadata standards for the WPLE system.

5. Key system tools

Our ideas on adaptive and personalised systems development were framed by earlier work (most notably: Brusilovsky & Nijhawan, 2002; Brusilovsky & Peylo, 2003; Frias-Martinez *et al*. 2005; Keenoy *et al*., 2005; Magoulas and Chen, 2006a, 2006b; Magoulas *et al*. 2003; Chen & Magoulas 2005). Key tools that could be provided by an adaptive system are as follows:

- **TEBO configuration tools:** for the authoring and assembly of TEBOs, and their registration with the system. This registration process will include the manual entry of the necessary metadata about the TEBO, in its role as a learning resource within the system.
- **Scenario support tool:** for the construction of scenarios and their registration with the system. Again, the registration process will include the manual entry of the necessary metadata about the scenario, in its role as a learning resource within the system. It also will be possible for the system to retrieve existing scenarios, on the basis of search terms input by the user e.g. based on key concepts and possibly additional information about the client (age, gender, educational and work history etc.) and the client's needs. The user will then be able to use the scenario(s) retrieved by the system, or modify and extend them as necessary.
- **User registration tool:** to register different categories of users with the system, and gather initial information about them.
- **Learning and Interaction Trail design tool:** for the specification and storage of learning and interaction trails. For this, the use of an open-source learning management system, such as LAMS, could be investigated.
- **Information gathering tools**: these will be provided by the system in order to assist learners in the retrieval of learning resources that are relevant to their needs and current context. Searching and browsing tools will be provided, accepting as search terms either keywords and search phrases, or terms drawn from the system's metadata schemas (c.f. catalogue-based search), or combinations of these.
- **Communication tools:** these could support, encourage and sustain peer-peer, peer-mentor and peer-expert discussion. Here, the use of Web 2.0 applications would be investigated.
- **Monitoring and logging tools:** these will monitor and log users' interactions with TEBOs and other learning resources. A key research question is what information should be gathered, and how should this information be represented internally in order to support efficiently the system's functions that build on it. One proposed methodology could be to 'instrument' the system from the outset, and to use the log information gathered in order to research how users are interacting with the system. This would then enable us to enhance the system's functionalities, and also to design appropriate adaptation tools to further personalise the learning experience towards specific practitioners' and clients' goals and needs.
- **Adaptation tools:** these would provide the system's adaptive functionality, making use of the system's current knowledge of users and learning resources, and of the usage by users of the learning resources (as recorded in the system logs). The adaptation tools would include **filtering, recommendation** and **notification** services. In particular, for the recommendation tools, we envisage employing computational intelligence techniques such as clustering and case-based planning, while for the notification tools event-condition-action rules would be a possible candidate technology. It is envisaged that the adaptation tools would be developed (depending on appropriate funding support) after a first, non-adaptive, version of the system has been developed, deployed and evaluated. Appendix C of this report lists a sample set of possible personalisation services that could be supported by the final system.

6. Roles of people who will use the system ('actors')

The main users of the system are expected to be the following:

- **Designers:** will design the scenarios, TEBOs, learning materials, case studies, and learning/interaction trails; during the course of a future full research project this role would be undertaken by the research team; in the longer term, designers could also include people drawn from the stakeholder communities
- **Content Authors:** NGRF researchers and the research team in collaboration with stakeholder communities, with the balance of input shifting more towards the stakeholders in the longer term
- **Practitioners**: front-line practitioners who interact with clients will be using the TEBOs, learning materials, case studies, learning/interaction trails, and tools provided by, and accessible from, the system.

Other people who will interact indirectly with the system, via one of the above roles include:

- **Clients**: indirect interaction through practitioners
- **Technical Experts** on financial products and (possibly) labour market information: will interact indirectly with the system through designers and content authors
- **Work-based trainers** of practitioners: this role is not so relevant for careers guidance at the current time but may become more relevant in the future as an attempt is made to make guidance more LM-focused
- **Tutors and mentors involved in initial training** are very likely to use the system, in some cases working with students and in other cases encouraging students to work together in developing their TCS; in the longer term, tutors may also become involved in design of TEBOs for use in particular contexts
- **Managers** of all the above categories of staff.

7. Use Cases

We have identified 5 major use cases of the system:

- DESIGN
- LEARNING
- COMMUNICATION-DISCUSSION
- CONFIGURATION
- INFORMATION SEEKING

The last of these use cases may be seen as subsidiary to the others, in the sense that it may be invoked in any of the other use cases in order to accomplish goals deriving from that setting, though it could also be directly invoked.

Further details of these use cases are as follows:

Name: **DESIGN**

Actor: Designers and Content Authors

Description:

This use case includes the creation, update and deletion of scenarios, TEBOs, learning materials, case studies, and learning/interaction trails. Designers and authors would select to view a list of design tools. They would select an appropriate tool, or invoke the system's search services to search for such a tool. Interacting with this tool, they would create/update/delete learning resources.

Name: **LEARNING**

Actor: Practitioner

Description:

This use case involves the interaction with scenarios, TEBOs, learning materials, case studies, learning trails, and information gathering and communication activities, in order to satisfy a learning need. Practitioners would select to view a list of learning resources. They would select an appropriate resource for their current learning goal, or invoke the system's search services to search for such a resource. They would then interact with the resource (and possibly other learning resources linked to it) in order to meet their learning goal.

Name: **CONFIGURATION**

Actor: Practitioner with Client

Description:

This use case includes the creation and use of context-specific interaction trails and TEBOs for a particular client or category of clients. Practitioners would select to view a list of resources that could be configured and used with a client. They would select an appropriate resource for their current configuration goal, or invoke the system's search services to search for such a resource.

They would then interact with the resource (and possibly with other resources linked to it) in order to meet their configuration goal.

Name: **COMMUNICATION - DISCUSSION**

Actors: Practitioners

Description:

This use case includes the creation of reflections and annotations by practitioners on learning and client-interaction resources; the sharing of these annotations with other practitioners; and personal development planning aspects. Practitioners would select from a set of discussion and annotation tools in order to generate reflections and annotations on learning resources. They would also be able to invoke the system's search services to search or browse the reflections/annotations of others on selected resources.

Name: **INFORMATION SEEKING**

Actor: Designer; Practitioner; Practitioner with Client

Description:

This use case involves interaction with data sets, and with information gathering and communication tools, in order to satisfy an information need. This may relate to the need of a designer or practitioner, or the need of a client with whom a practitioner is interacting.

8. Usage Scenario: possible ‘learning trails’ through the system

We next present an extensive usage scenario of the system, which sets out how practitioners might navigate through a sequence of the above Use Cases – we can view this as a framework through which users might move, following different ‘learning trails’, in order to develop their TCS (see Figure 1). Our concern in developing this framework was to explore collectively how the learning and development potential of TEBOs situated within a learning environment that offers community-driven knowledge sharing and learning might be integrated into guidance practice. Hence not all important aspects of the WPLE are explored here, for example, the ways in which the system might be used by trainers or managers to monitor learner progress or to modify learning resources, nor the adaptation tools.

We note that this framework diagram served as a crucial boundary object between IOE / Warwick and Birkbeck as a support to interdisciplinary dialogue. Discussion of its design and meaning helped to resolve early tensions between the former’s tendency to focus generally about what the WPLE should be able to do, and the latter’s tendency towards precise specification and concrete details. As work progressed, the diagram became a mediator for the sharing and development of ideas.

At this time, we will focus solely upon the type of tools available and activities possible at different stages of the process; how a user might progress through this trail is the focus of the Demonstrator in Section 10.

At Level 1 practitioners gain access to exemplar case studies, and searching and browsing tools to locate appropriate material and ways for users to explore their need for learning and development of TCS.

At Level 2 practitioners can choose the area(s) in which they require learning support; bring together different types of resources to satisfy a learning need; access data that they may need to deal with a particular client query; and use Communication-Discussion tools to consider how to get LMI-informed messages through to clients.

At Level 3 practitioners are able to access TEBOs, data sets, and a range of other learning resources. They are also able to self-assess the extent of their current TCS.

At Level 4 practitioners can make use of opportunities for critical reflection, invoking again the Communication-Discussion tools. They are also able to access help facilities.

At Level 5 (groups of) practitioners are able to make use of opportunities for Configuration, whereby they can tailor learning resources according to their and their clients needs. Additionally, organisations with an interest in guidance in particular contexts (stakeholders) can extend and customise the WPLE according to the requirements of their communities, using a range of tools to support adaptation.

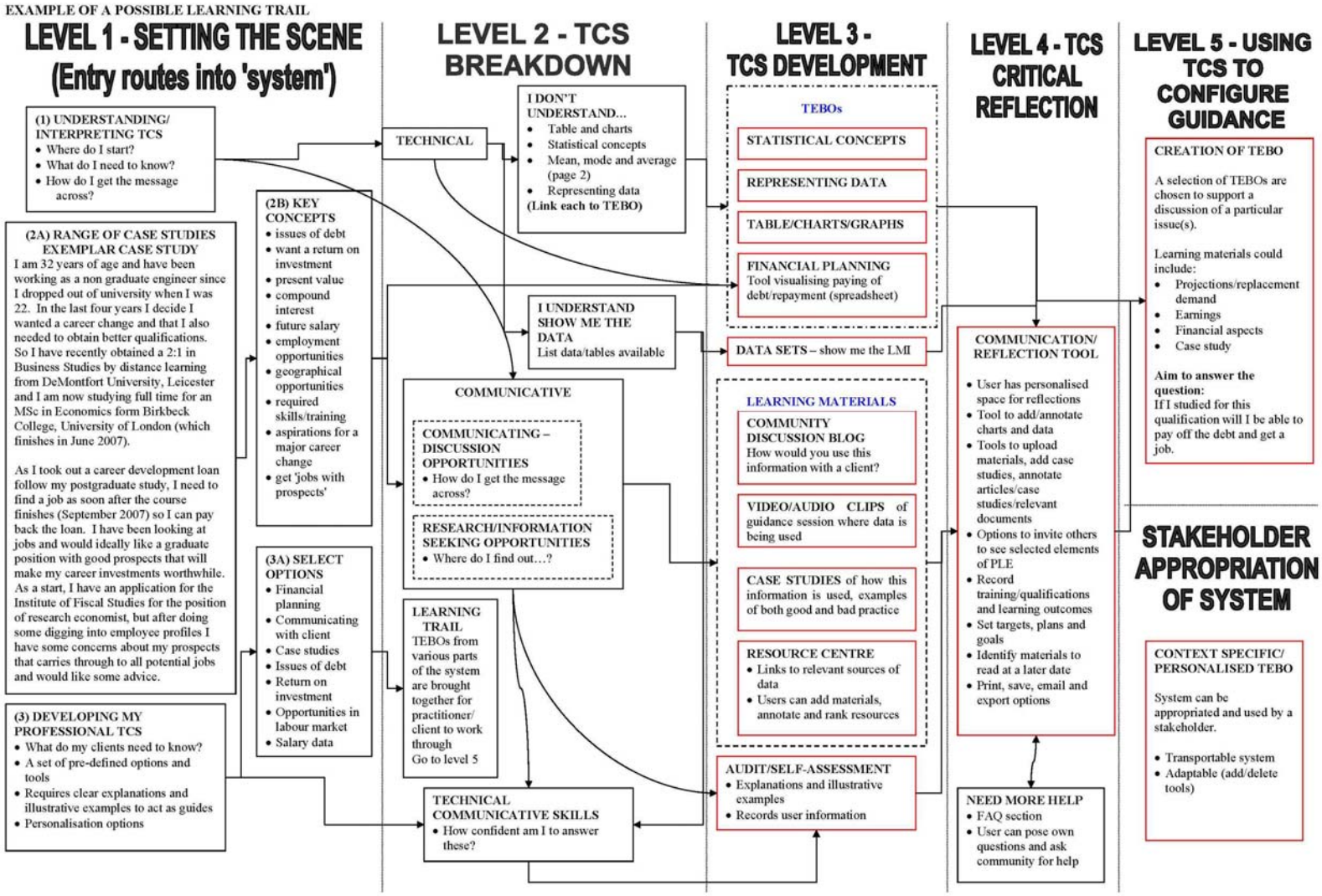

Figure 1: Example of a possible learning trail

9. System Architecture

A full system implementation would consist of a set of components and services, as illustrated in the architectural diagram (Figure 2). The architecture comprises three levels: (a) the User Interface, (b) the application services and (c) the back-end services.

The User Interface will be a portal, serving as a platform for invoking the application and back-end services, and presenting in a user-friendly fashion the entirety of the system's functionalities.

The application services include: User Registration services, TEBO Configuration services, Learning & Interaction Trail Management services, Scenario Support services, Communication & Discussion services, Search & Browsing services, and Monitoring, Logging & Adaptation services.

These services will support Web Service interfaces. They will accept requests from the User Interface and will undertake the appropriate application logic. This application logic will invoke the necessary back-end services, including actions relating to storing, retrieving and modifying the learning resources, metadata and logging data, annotations and reflections, and external data sets. The results of invoking an application service will be passed back to the user interface: for example, as XML.

The back-end services will comprise existing Learning Activity Management, Repository Management, Data Access, and Web 2.0 tools. These tools will connect with underlying repositories for storing, retrieving and modifying learning resources, metadata and logging data, annotations and reflections, and external data sets. The external data sets will be externally developed, while the rest of the repositories would need to be designed by the research project team. In particular, for the metadata relating to learning resources and learners, we envisage using and extending as appropriate existing metadata standards, as listed in Appendix B of this report. Such metadata could be stored in a MySQL database (http://www.mysql.com), using the Jena framework (http://jena.sourceforge.org) as a wrapper over the database, providing mechanisms for storing, retrieving and querying the metadata.

An architectural overview of the system is presented in Figure 2.

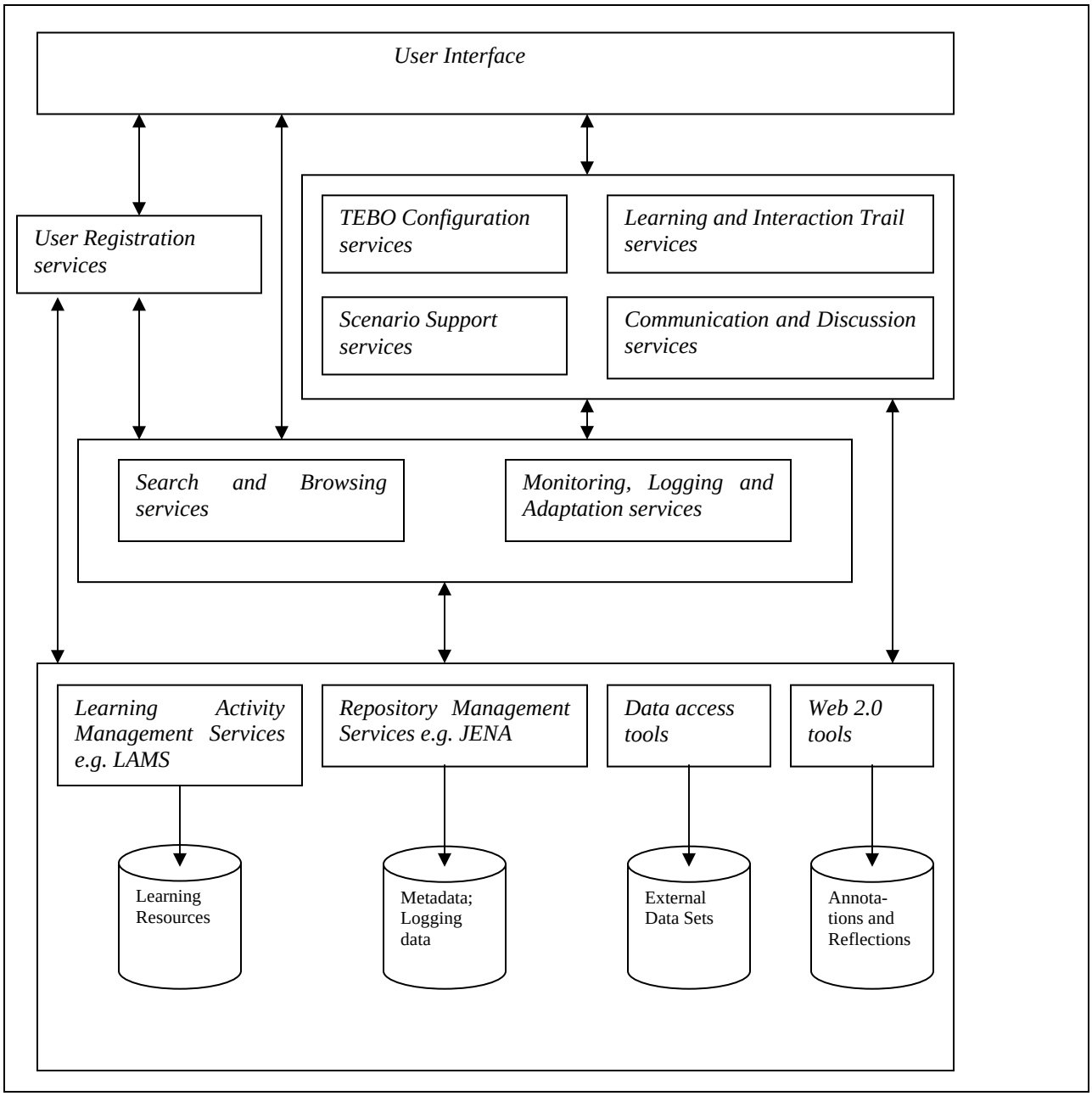

Figure 2: TCS Learning Environment – Architectural Overview

10. A demonstrator of how the WPLE might work in practice

The following demonstrator represents an attempt to take the specification for the WPLE and to exemplify what one implementation of this might look like in practice.[9] Some screenshots drawn from an outline on-line demonstrator are given in Appendix D. The demonstrator is also available at http://www.optatus.de/cfp/02_home.htm

This section provides an overview of what we were trying to achieve with the development of the demonstrator. The starting point for this was what the research team, after extensive consultations with practitioners, expect the system to be able to do from a practice-oriented perspective. The software developers then worked with the research team to construct a mutually agreed representation of the 'story' of how users might move through the system.

Guidance practitioners need to enhance their ability to interpret and communicate information about labour markets and issues around financial planning and incorporate this in their guidance. One way to achieve this is through the development of compelling, technology-enhanced boundary objects (TEBOs) – problematic and conceptual – in order to facilitate 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, case studies, communication tools, information gathering/filtering tools and other external tools, aimed at achieving a particular learning goal or goals. The demonstrator gives one example of how an individual might move through the system (e.g. the learning trail provided in Appendix D. In practice, learners will make choices in their routes dependent on the context in which they are using the system, their learning needs and their past experience.

The demonstrator illustrates a learning pathway. It demonstrates the potential resources and functionality which a user might access in navigating though the system. At each point of the learning trail it will be possible to access a system map showing where each element fits within the overall system (e.g. see Fig. D1).

One important introductory note is that the WPLE is, as the name suggests, an environment – the demonstrator or any other implementation is not itself a PLE; rather the PLE comprises a suite of services which can be developed and then accessed in particular contexts. Hence it may be useful

[9] The change in policy context with the proposed set up of a universal adult guidance service in England with a requirement for practitioners to have a deeper understanding of the labour market in order to inform the career guidance they offer to clients (following the lines recommended in the Leitch Review, 2006) means that the search as to how to support practitioners develop their TCS has become an urgent issue. Additionally, guidance services and policy actors concerned with policy implementation have agreed to work with us (and fund on a modular basis) different technical components of an integrated learning system, such that by September 2008, we will have a 'lightweight' PLE system and some more substantive TEBOs in place. This means that this exercise involving the specification of a demonstrator has taken on real practical significance.

to think of this demonstrator as a particular learning system that is under development, whereas the full PLE is the suite of services and tools outlined in the previous sections.[10]

10.1 The services accessible throughout the site

The left side-bar (see Fig. D1) will allow an individual to:

- **Register:** gather initial information about the user but also the individual to register in one of a number of different categories of users with the system (with varying permissions)

- **Configure:** gives users the opportunity to configure the 'look and feel' of the site and to access those particular services and facilities in which they are interested

- **Recent items:** just helps the user keep up-to-date regarding new posts

- **What is new**: allows system designers to point to significant new content

- **Who is online**: who else is currently using the system

Note some of the following services may or may not be available depending on the type of user registration:

- **TEBO design:** will give entry to a suite of **TEBO configuration tools** that can be used for the authoring and assembly of TEBOs, and their registration with the system.

- **Build a scenario:** will give entry to a suite of **scenario support tools** that can be used for the construction of scenarios and their registration with the system, including entry of metadata about the role of the scenario as a learning resource within the system. The user will be able to retrieve and adapt an existing scenario or build a new one from scratch.

- **Learning Trail design:** will give entry to a suite of tools that would facilitate **Learning and Interaction Trail design.** These tools will enable the specification and storage of learning and interaction trails – that is, they will record how learners could move through the system as a whole to achieve particular purposes.

- **Information gathering:** will give entry to a suite of **Information gathering tools** that will be provided by the system in order to assist learners in the retrieval of learning resources that are relevant to their needs and current context. Searching and browsing tools will be provided.

[10] Compare the CETIS approach which emphasised the distinction between a Personal Learning toolkit from which choices can be made for a particular user, whereas a Personal Learning Environment comprises an environment of services which are accessed through the Personal Learning toolkit (Johnson *et al*., 2006).

- **Learning System design:** will give entry for designers, content authors and experts (e.g. guidance services) to be able to access a suite of tools that would facilitate them designing an entire learning system for their particular contextualised purposes.

- **Adaptation tools:** will give entry for content authors, experts (e.g. guidance services) or current system designers to be able to access a suite of tools that could be used to enhance the system's adaptive functionality, making use of the system's current knowledge of users and learning resources, and of the usage by users of the learning resources (as recorded in the system logs). The adaptation tools could include **filtering, recommendation** and **notification** services as discussed in Section 5. Additionally further personalisation services could be developed as listed in Appendix C.

10.2 Embarking on a learning trail

10.2.1 The idea of a learning trail

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 and examples of good and less good practice. The scenarios are intended to highlight the need for users to develop their Technical Communicative skills and practitioners could then choose to develop their TCS in relation to a number of particular issues. It would also be possible for users to undertake an individual audit / self assessment of their TCS.

Once the need has been established that some TCS development is required then the users should be able to embark on a learning trail that offers alternative ways of representing, understanding and interpreting tables and charts, including helping users understand the underlying statistical and labour market concepts. Some of these materials may be simple boundary objects (tables and charts with explanatory text). There will also be TEBOs that are more powerful visual representations that allow for interaction and could help transform how practitioners view the relationships between data. Users will also be provided with links to LMI data sets that will enable them to enhance their understanding of LMI trends, how financial planning 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 what information they are particularly interested in and will also have access to communication / reflection tools in order to help them work on the chosen data. The demonstrator will also provide sections that will enable users to browse frequently asked questions or to enter their own questions.

10.2.2 Different ways of helping practitioners to acknowledge that they may need to develop their technical communicative skills

The practical orientation of the WPLE is emphasised in the overall approach to Understanding and Interpreting Technical/Communicative Skills. Practitioners thinking about their TCS may ask themselves three questions:

- Where do I start?
- What do I need to know?
- How do I get the message across?

Answers to these questions are reflected in the different ways into and through the learning trails. For those who are clear that they need to update their skills, or who are perhaps making a return visit, it is important for them to be able to access material directly that will help them understand and develop their TCS. A second option will be to take a self-audit of their TCS and to find out what types of learning and development may be appropriate for them. The third way into a trail will be through the type of scenario outlined in Section 2 of this report (see Fig. D2 and D3). It is felt that this will be a means through which practitioners will be able to engage with client concerns about their career and financial planning and recognise that their own TCS may need developing.

10.2.3 Working with scenarios and TEBOs

The scenarios highlight the importance of a number of key issues that users may want to explore further. For example, from the exemplar case study outlined in Section 2 above, a user may wish to explore some of the following issues further:

- 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 act as a bridge between more and less technical understandings and representations (see Fig. D5). However, given that the users need not just to be able to understand and interpret the relevant technical information, but also to be able to use it with clients, there will also be a community discussion blog that will focus upon how practitioners would use LMI with a client. Additionally there will be video/audio clips of guidance sessions where data is being used; case studies of how this information is interpreted, and examples of both good and bad practice, as part of a more general resource centre.

Working with these issues may also lead a practitioner to engage with more comprehensive LMI on a particular topic. This in turn may mean that a practitioner could see that there are other scenarios that could be developed to treat this issue in a way that is more relevant to their particular context. It may be that a number of TEBOs dealing with particular technical issues could be aggregated in order to address a particular guidance issue. In these cases the designers could work with practitioners in order to construct a complete learning package. For example, learning materials could be drawn together around TEBOs linked to:

- Projections/replacement demand
- Earnings
- Financial aspects

All of these could then be put together in order to inform an answer to the question: 'If I study for this qualification, will I be able to pay off the debt and get a job?'

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. Finally, it may 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 TEBOs for use in a particular context. The prospective creators may wish to work with the designers in order to develop their skill sets so as they are able to work independently in the construction of their own system that draws upon the approach outlined here.

10.2.4 Working with LMI data sets

As practitioners follow a particular learning trail, as well as working with TEBOs and other learning resources, they also get the opportunity to work with LMI data sets (Fig. D6) in order to develop their TCS (or possibly just to find information linked to a particular client requirement). Practitioners can work with communication and reflection tools in order to enhance their understanding of LMI trends, and how financial planning and career planning are becoming entwined, and to reflect upon how best to draw on this information when working with clients. They will also be able to choose which information they are particularly interested in, to draw that information down from the National Guidance Research Forum Future Trends section, and then to call up the communication/reflection tools for working on the chosen data.

10.2.5 Using communication and reflection tools

The Communication and Reflection tools are intended to help practitioners to reflect critically upon LMI and how they might use it with their clients. The tools provide:

- A personalised space for reflections
- Tool to add/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
- Record training/qualifications and learning outcomes
- Set targets, plans and goals
- Identify materials to read at a later date
- Print, save, email and export options.

10.2.6 Opportunities for communication, research and self assessment

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 in 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?

10.2.7 Full set of learning materials

As practitioners follow their learning trails, as well as engaging with TEBOs, scenarios and LMI data sets (see Fig. D7-D11), they will also have the opportunity to access a communtiy discussion blog, video and audio clips of guidance sessions where data is being used and shows 'TCS in action', case studies of the use of labour-market informed guidance (which could include examples of both good and less good practice) and links to relevant sources of data. Users themselves would be able to add to the materials, as well annotating and ranking resources.

10.2.8. Stakeholder appropriation of the system

One outcome of successful journeys by practitioners may 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 TEBOs for use in a particular context. The prospective creators may wish to work with the designers in order to develop their skill sets so as they are able to work independently in the construction of their own system that draws upon the approach outlined here.

11. Conclusion

This report has considered how a system might be operationalised to support the development of TCS in the context of career guidance and financial planning, and has presented an outline specification from user, system and computational perspectives of such a system. The ability of the technologically-enhanced boundary objects (TEBOs) to act as mediating tools for the development of TCS was an important starting point, with the challenge being how to situate work with TEBOs in the context of a WPLE in order to facilitate development of practitioners' TCS.

We have presented a specification of the key aims, learning resources, tools, users, and use cases of the system, together with an outline system architecture. The advantage of such an approach is that the system can subsequently be incrementally and iteratively constructed around what the different parts of the system and the system as a whole are intended to do. We have also developed an extensive usage scenario of the system - a 'learning trail' through which users would move in order to develop their TCS in a way that draws upon the transformative potential of TEBOs situated within a learning environment that offers community-driven knowledge sharing and learning. This used a practice-oriented perspective, and the software developers and research team worked together to construct a mutually agreed representation of the 'story' of how users might move through the system. This usage scenario was taken as the basis for the demonstrator that shows how ideas from TEBO development and PLE implementation could be drawn together. The demonstrator invokes some possible adaptive features in relation to TEBOs, but as was made clear in our original project objectives, the 'demonstrator would not include the actual adaptation and personalisation functionality, metadata repositories, activities, learner models etc.' that would be an aspect of future work.

The research as a whole has shown that the approach to TEBO development and PLE implementation outlined in this report does indeed offer the prospect of a theoretically informed and pedagogically sound approach to the development of the TCS of guidance practitioners as part of a LMI-informed approach to careers guidance which builds on techno-mathematical knowledge. The real achievement of this project, however, can be gauged by the full engagement of the community as a whole not only to accept our analysis and proposed way forward as sound, but also in their commitments to help realise what is proposed in three ways. First, guidance services and policy actors concerned with policy implementation have agreed to work with us on (and to fund on a modular basis) different technical components of the integrated learning system we propose in our TEL 2 proposal, such that by September 2008, we will already have a 'lightweight' PLE system and some prototype TEBOs in place. Second, with the full support of the community as a whole, we are setting up an 'innovation group' to consider how inter-related changes in learning, development and practice of career guidance may be achieved. Third, if we are successful in obtaining ESRC support in the TEL 2 proposal, it will be possible to generate additional support for customisation of TEBOs for particular sectors and guidance services. The community has previously committed considerable financial resources to support the development of a national learning resource and knowledge stewarding community (National Guidance Research Forum). However, what this (TEL 1) project has done is to identify that in order to move to the next stage of development, an innovation community for guidance practitioners, the community faces significant learning and development challenges that can only met by the type of inter-disciplinary collaborative research outlined in our TEL 2 research proposal (see Appendix E for further details).

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Appendix A: Questions discussed and material used in the user consultation on TinkerPlots prototype TEBO

Hands-on activities: Exploring LMI data with TinkerPlots – "Seeing the individual in the mass of the data"

12th June 2007, consultation with eight trainee practitioners

1. Introduction

This activity presents a set of data about earnings for a sample of 2677 adults across the UK, with a variety of information about each person – age, education, location of work and type of work. (It is extracted from the National Statistics "Labour Force Survey", October-December 2006).

We would like to know how useful you find it to access "raw" data like this – compared with most LMI which, for example, simply quotes average values for different types of jobs, or gives "pie chart" breakdowns of data samples.

We would much appreciate to know what kinds of questions **you** think are interesting to ask about this data, and LMI data in general, using a tool like TinkerPlots.

Can you think of "client scenarios" to illustrate your questions?

2. Starting the software

Double click on the file "LFS survey data.tp".

1. Lets start by looking at the range of salaries in the data. So we select the attribute 'GROSS_PAY' on a data card and drag one circle in the plot sideways to the right. What happens? What happens if you drag the circle a little more to the right again? And again? Try to make sense of what is happening if you drag one circle all the way to the right.

2. Try clicking the vertical 'Stack' button. You can adjust the circle size with the slider in the toolbar underneath the plot, or choose a different shape icon.

3. You have now organised the plot as a basic distribution of salaries. There are various tools at the top of the screen which help to summarise the data: try clicking on the different options in 'Averages' and 'Hat'.

3. Scenarios

Scenario 1

Consider the following client scenario:

> 'I live in East London, but grew up in Scotland. I work in computer sales. I'm considering relocating with my wife and children to Scotland, because there is a better quality of life, and we can be closer to relations. But I'm out of touch with what's happened to salaries outside of London. I'd expect to earn less, but what are salaries like in Scotland now?

What information can the data provide that informs this client's case?

Hint: Click on the attribute "country" in the data card. Drag a circle upwards to separate the data by country. Keep dragging circles until the data are separated by country (England, Wales, Scotland, Scotland North, Northern Ireland).

Scenario 2

> 'I've been working in financial administration for the past 12 years and hate it, but the salary is quite good (£20,000). English and writing is what I really love to do. If I finance myself through an English course at University, will I be able to get a decent job at the end of it?'

Scenario 3

> 'I'm part-way through my degree in business studies. I have set myself a personal goal of earning £50,000 a year within 5 years of graduation. Can you advise me?'

4. Reference information drawn from the Labour Force Survey data

Degree subject classifications in this sample data set

(Note: this is simplified from the orginal LFS subject classification)

Medicine/Dentistry	Tourism	Archaeology
Medicine	InformationManagement	Philosophy
Dentistry	MediaStudies	Theology
SocialStudies	Journalism	FineArts
Economics	Linguistics	Design
Politics	EnglishStudies	Music
Sociology	Arabic	Drama
SocialPolicy	Latin	Dance
SocialWork	GreekClassics	Photography
Anthropology	Classics	Crafts
Geography	French	CreativeWriting
Law	German	Arts&Design
BusinessStudies	Italian	Education
Management	Spanish	Teaching
Finance	RussianEastEuropean	MedicalRelated
Accounting	EuropeanStudies	Physiology
Marketing	AsianStudies	Physiotherapy
HRManagement	AmericanStudies	Pharmacology
OfficeSkills	History	ComplementaryMedicine

Nutrition
Optometry
SpeechScience
Nursing
Radiology
OccupationalHealth
Biology
Zoology
Genetics
Microbiology
SportsScience
Biochemistry
Psychology
VeterinaryScience
Agriculture
FoodScience
Chemistry
MaterialsScience
Physics
Forensics
Geology
MarineScience
GeographicalScience
MathematicalSciences
Mathematics
OperationalResearch
Statistics
ComputerScience
InformationSystems
SoftwareEngineering
Engineering
CivilEngineering
MechanicalEngineering
AerospaceEngineering
NavalEngineering
ElectricalEngineering
ProductionEngineering
ChemicalEngineering
MiningMinerals
Metallurgy
Ceramics
Polymers&Textiles
MaterialsTechnology
MarineTechnology
Technology
Architecture
Building
LandscapeDesign
Planning

5. SIC92 codes used in the TinkerPlots material: Industry divisions

(1) A: Agriculture, hunting and forestry

(2) B: Fishing

(3) C: Mining, quarrying

(4) D: Manufacturing

(5) E: Electricity, gas & water supply

(6) F: Construction

(7) G: Wholesale, retail & motor trade

(8) H: Hotels & restaurants

(9) I: Transport, storage & communication

(10) J: Financial intermediation

(11) K: Real estate, renting & business activities

(12) L: Public administration & defence

(13) M: Education

(14) N: Health & social work

(15) O: Other community, social & personal

(16) P: Private households with employed persons

(17) Q: Extra-territorial organisations & bodies

6. SOC2000 codes used in the TinkerPlots material

The first digit gives the overall occupation type:

1 Managers and senior officials

2 Professional occupations

3 Associate professional and technical occupations

4 Administrative and secretarial occupations

5 Skilled trades occupations

6 Personal service occupations

7 Sales and customer service occupations

8 Process, plant and machine operatives

9 Elementary occupations

7. UK region codes used in the TinkerPlots material

Work regions:

(1) Tyne & Wear
(2) Rest of North East
(3) Greater Manchester
(4) Merseyside
(5) Rest of North West
(6) South Yorkshire
(7) West Yorkshire
(8) Rest of Yorks & Humber
(9) East Midlands
(10) West Midlands (met area)
(11) Rest of West Midlands
(12) East of England
(13) Central London
(14) Inner London
(15) Outer London
(16) South East
(17) South West
(18) Wales
(19) Strathclyde
(20) Rest of Scotland
(21) Northern Ireland
(22) Workplace outside UK

Residential regions:

(1) Tyne & Wear
(2) Rest of Northern Region
(3) South Yorkshire
(4) West Yorkshire
(5) Rest of Yorkshire & Humberside
(6) East Midlands
(7) East Anglia
(8) Inner London
(9) Outer London
(10) Rest of South East
(11) South West
(12) West Midlands (Metropolitan)
(13) Rest of West Midlands
(14) Greater Manchester
(15) Merseyside
(16) Rest of North West
(17) Wales
(18) Strathclyde
(19) Rest of Scotland
(20) Northern Ireland

Appendix B:
Building on Metadata Standards

Standardisation in the area of educational technology is important for enabling interoperability between different learning-related systems, for facilitating cross-institutional and lifelong learning, and for sharing and reusability of educational materials and other learning-related information. To this end, the use of metadata standards has been promoted in order to facilitate the exchange and sharing of learning-related metadata. In the context of e-learning, metadata standards are formal specifications that can be used to semantically annotate educational material of all kinds, and can themselves be considered as digital resources that can be reused to support learning. Table 1 below gives an overview of the main current e-learning metadata standards and their characteristics. Of these the most relevant for the envisaged WPLE are the Dublin Core, IMS and IEEE LOM standards for describing learning resources, and the IMS LIP and PAPI standards for describing learners.

Metadata Standards	Description
IMS- Instructional Management System and IMS LIP- IMS Learner Information Package (www.imsglobal.org)	A set of specifications for describing various aspects of learning materials and processes, having as its main goal to facilitate interoperable learning technology applications. IMS LIP provides a flexible way of representing information about the activities, achievements, goals and interests of learners, and also learners' characteristics for the purpose of personalisation of content.
ARIADNE- Alliance of Remote Instructional Authoring and Distribution Network for Europe (www.ariadne-eu.org)	The ARIADNE metadata standard has been produced as a result of collaboration between the ARIADNE project and the IMS organisation. ARIADNE is provides efficient Learning Object indexing and supports easy metadata exploitation by users. The ARIADNE metadata schema contains a number of mandatory and optional categories. The mandatory categories constitute a minimal set of attributes for supporting efficient searching capabilities.
DC- Dublin Core (dublincore.org)	The Dublin Core aims to develop interoperable online metadata standards that support a broad range of purposes. The Dublin Core can be summarised as a set of

	properties for describing documents.
IEEE/LOM- Institute of Electrical and Electronic Engineers/Learning Object Metadata (ltsc.ieee.org/wg12/)	IEEE LOM has been created from a joint proposal of IMS and ARIADNE to IEEE. It is a superset of Dublin Core and thus it can cooperate with it using DC elements for the definition of some basic LOM elements. The IEEE LOM standard specifies attributes required to describe a LO, and a minimal set of attributes for the management and evaluation of LOs.
ADL/SCORM- Advanced Distributed Learning/Sharable Courseware Object Reference Model (www.staffs.ac.uk/COSE/cosenew/SCORM.doc)	ADL SCORM uses the IEEE LOM metadata descriptions. It maps IEEE LOM elements into three learning content elements in order to provide the missing link between general metadata specifications and content-specific models. These three learning content elements are (i) Raw media (e.g. components, fragments), (ii) Content (e.g. lessons, modules) and (iii) Courses.
PAPI- Public and Private Information (edutool.com/papi)	The PAPI Learner Standard is a data interchange specification used for communication among cooperating systems. The PAPI standard specifies the semantics and the syntax of information associated with learners in a format appropriate for use by learning technology systems. It defines a set of elements for recording information concerning the learner including: knowledge acquisition, learner skills, abilities, security parameters, learner preferences and learner performance.
EduPerson Object class (www.angel.ac.uk/UKeduPerson)	An LDAP object class that includes widely-used person attributes in higher education. These person class descriptions can be used in campus LDAP directories in order to facilitate communication and user information interchange between educational institutions. A customised version of eduPerson, UKeduPerson, was developed by London School of Economics, driven by the needs of UK institutions to share learning and teaching resources more freely.

UKLEAP- UK Learning Profile (www.recordingachievement.org/downloads/Learner_Profile_V1.1.pdf)	UKLeaP is based on the application profiles of IMS LIP and is being developed through the Lifelong Learning Support Project and the CETIS[11] LIPSIG[12], funded by JISC and managed by the Centre for Recording Achievement.
XCRI- eXchanging Course-Related Information (www.elframework.org/projects/xcri)	XCRI is a JISC-funded project that defines a vocabulary and appropriate standards-based technology bindings (e.g. XML, RDF) for describing course-related information that encompasses course marketing, course quality assurance, enrolment and reporting requirements

Table 1 Metadata Standards.

[11] CETIS: Centre for Educational Technology Interoperability Standards

[12] LIPSIG: Learner Information and Profiles Special Interest Group

Appendix C:
Possible Personalisation Services for the WPLE

Table 2 presents a set of personalisation services relevant to the envisaged WPLE. The aim of personalisation is to enhance individual users' engagement with the system and to offer personalised levels of user support. Personalisation services can also support the formation of communities of users with similar interests, and facilitate information sharing with other members of the community and other users.

Personalisation Service	Functionality
Filtering	Searching for learning resources in a personalised manner by refining the search depending on attributes drawn from the learner's profile e.g. learner's individual preferences and goals.
Ranking	Adaptive ordering of the learning resources retrieved by a search, based on self-ratings and/or other users' ratings of the resources.
Customisation	Allow users to update their profile and preferences, and to activate/deactivate features of the system that depend on user preferences and learning goals. Personalise the delivery and presentation of content depending on user background, preferences and characteristics.
Recommendation	Provide recommendations of appropriate learning resources based on their properties, and the learner's characteristics, learning history and learning goals.
Reflective log	Allow users to record their reflections about their use of the system e.g. how their use of specific learning resources helped them to achieve a particular goal. The system can utilise such reflections and display them automatically to other users with similar characteristics and similar goals.
Rating	Support for creating and maintaining user ratings and user annotations of learning resources. Recording ratings of search results, implicitly or explicitly.
Automatic profile update	Support the mapping of learner activities using the system against specific learner competencies, allowing the automatic or semi-automatic update of learners' profiles.
Notification	Monitor learners' favourite learning resources e.g. as determined by their rating and their frequency of usage of specific resources. Detect changes to these resources, or modified reflections, and inform interested learners. Notify

	users about communication spaces that relate to their interests.
Communication	Create communication spaces for users with similar interests, e.g. developing weblogs with learners/designers belonging to the same community. Access to communication spaces can be personalised to meet the needs, interests and preferences of particular user groups.
Support and Feedback	Provide online support and feedback regarding the use of various system features and functionalities.

Table 2. Sample list of WPLE personalisation services.

Appendix D:
Screenshot illustrations of the Demonstrator

The full version of the Demonstrator can be accessed at:

http://www.optatus.de/cfp/02_home.htm

Screenshots showing how a guidance practitioner may follow a particular learning trail in order to develop their TCS.

Fig. D1. Demonstrator Home Page: WPLE for careers and financial planning

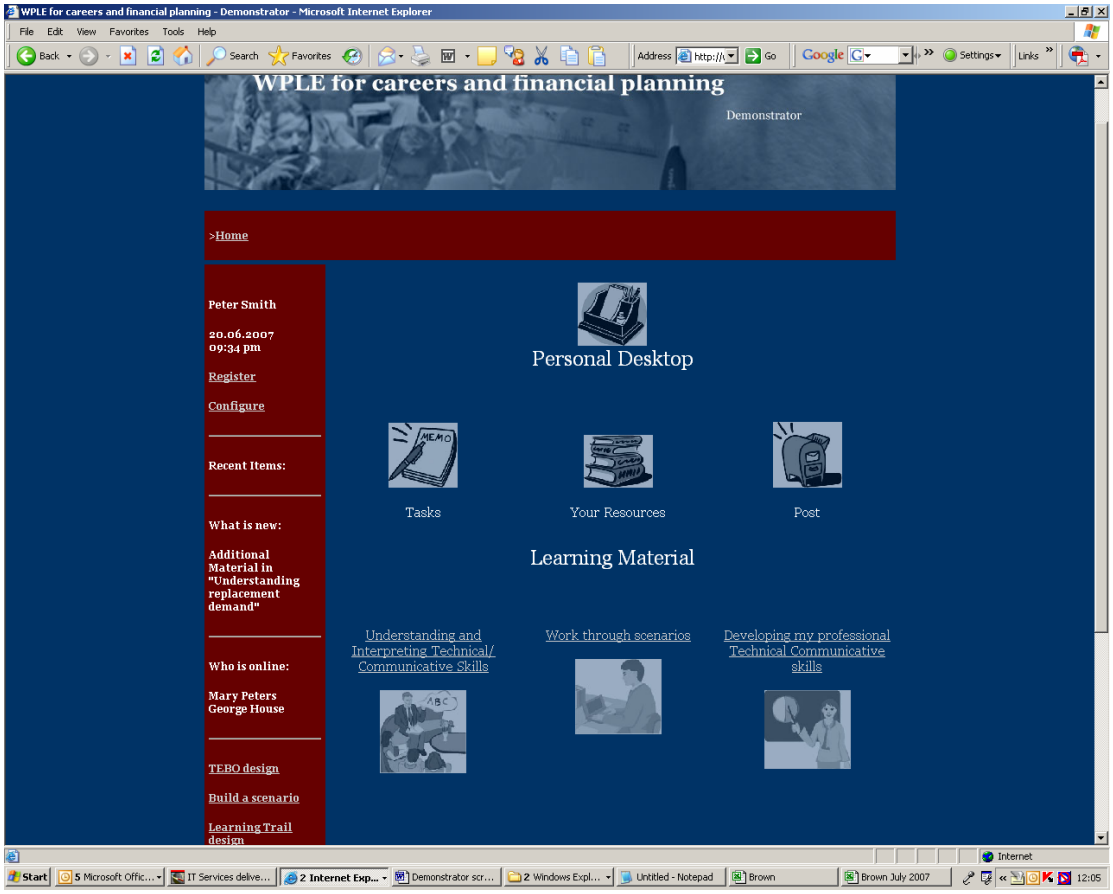


Fig. D2. Choosing ‘work through scenarios’ in order to establish the need develop your TCS

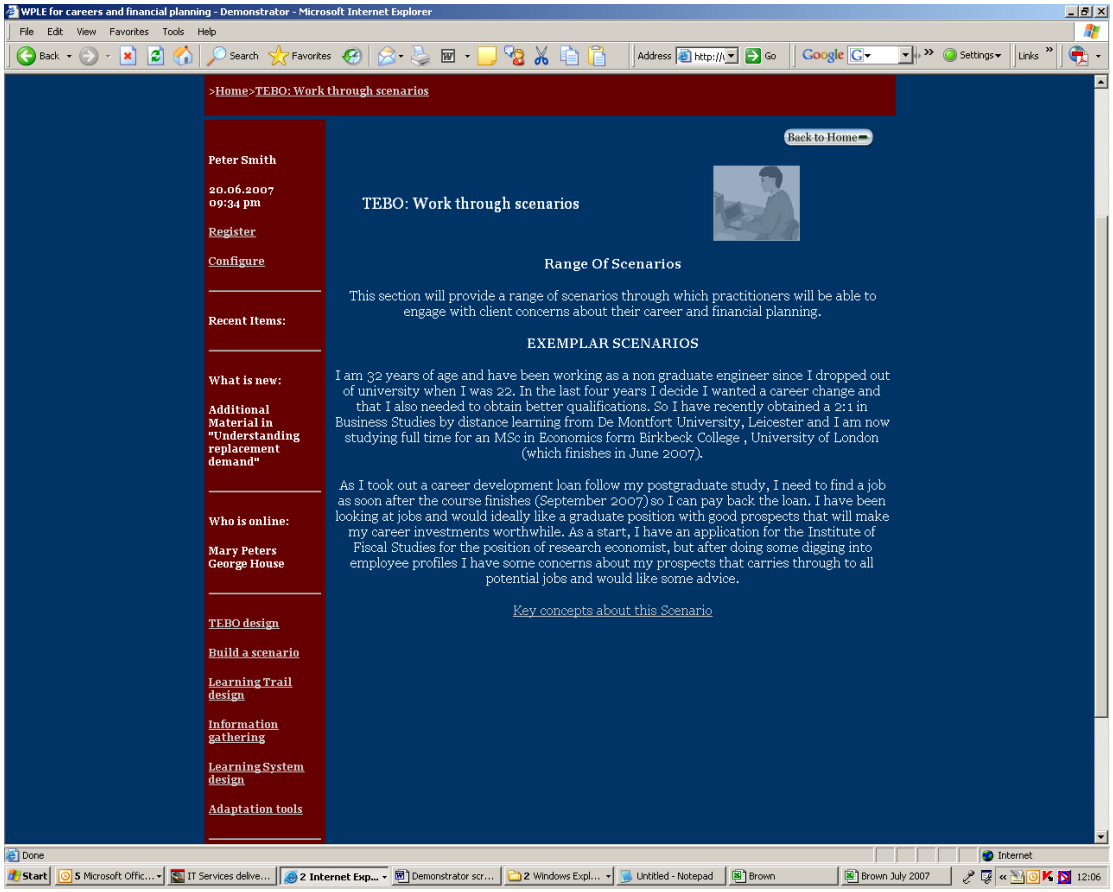


Fig. D3. Choosing ‘key concepts about the scenario’ to decide upon which issues to focus

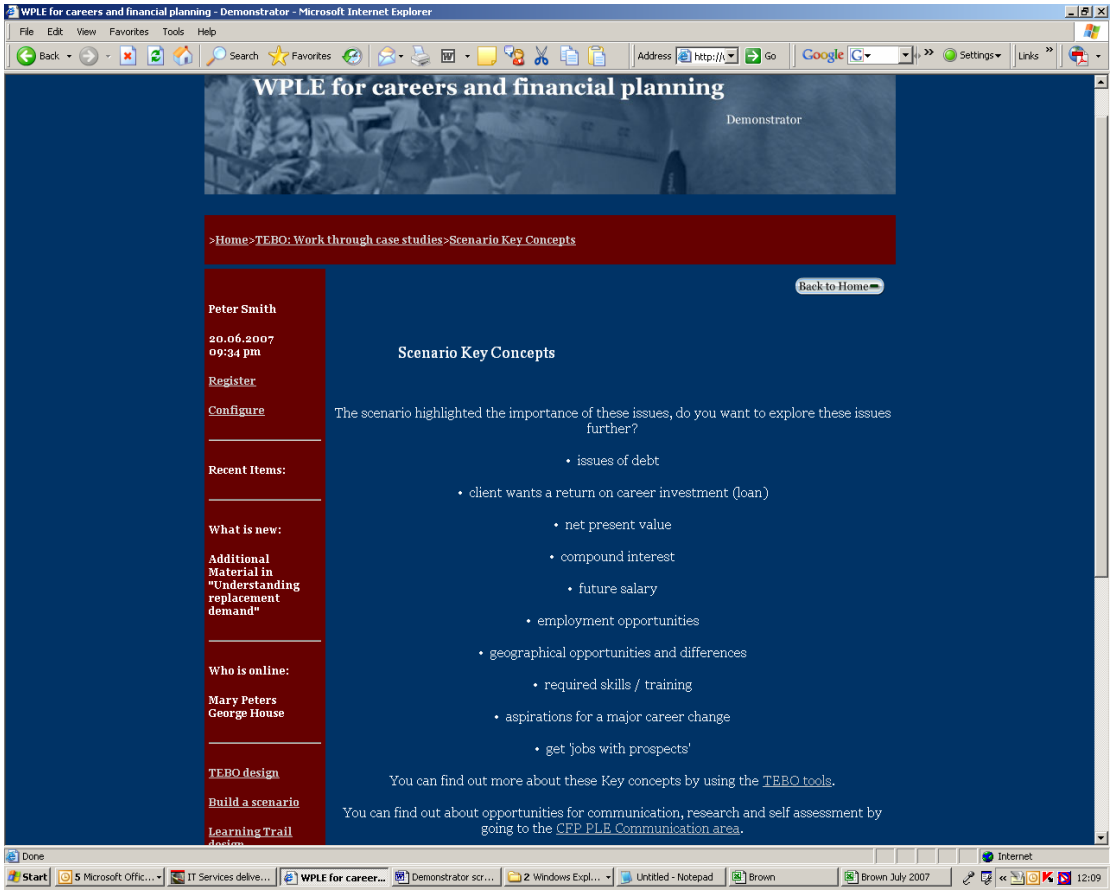


Fig. D4. Choosing ‘using the TEBO tools’ as a means to develop your TCS

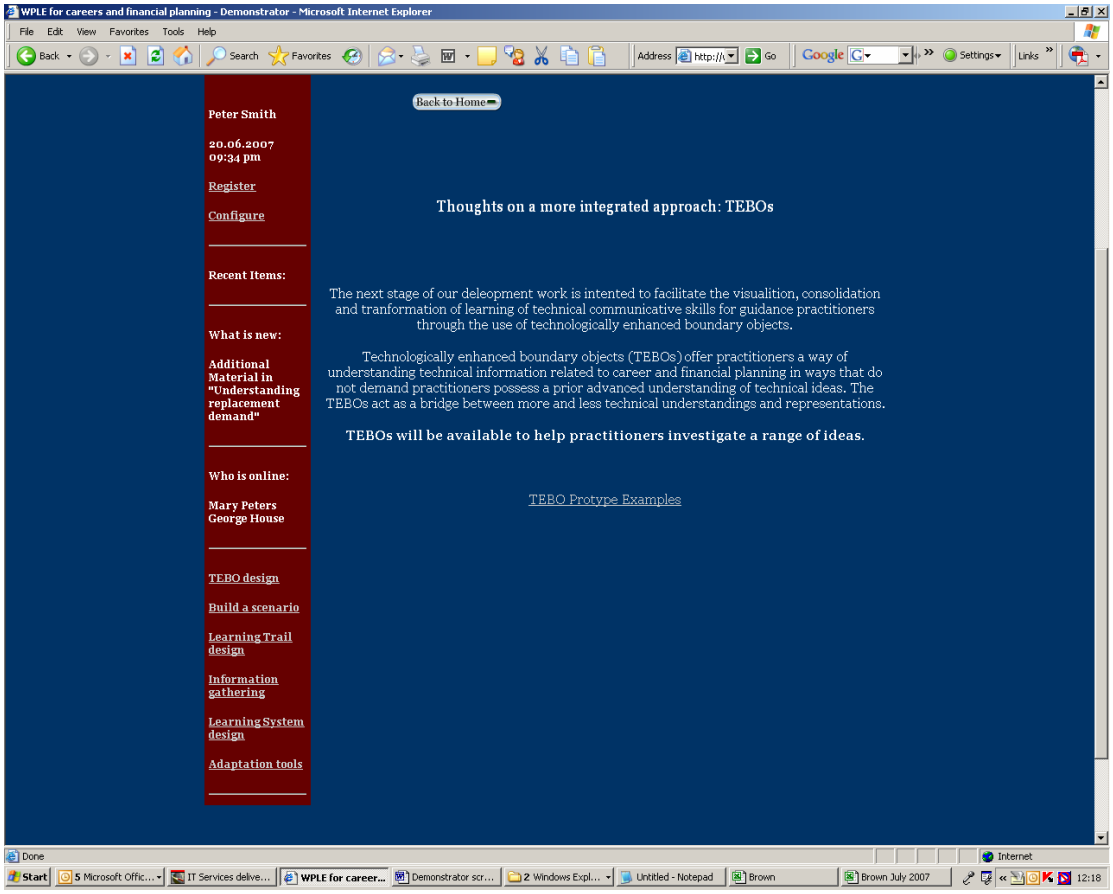


Fig. D5. Choosing ‘TEBO prototype examples’ as a means to develop TCS

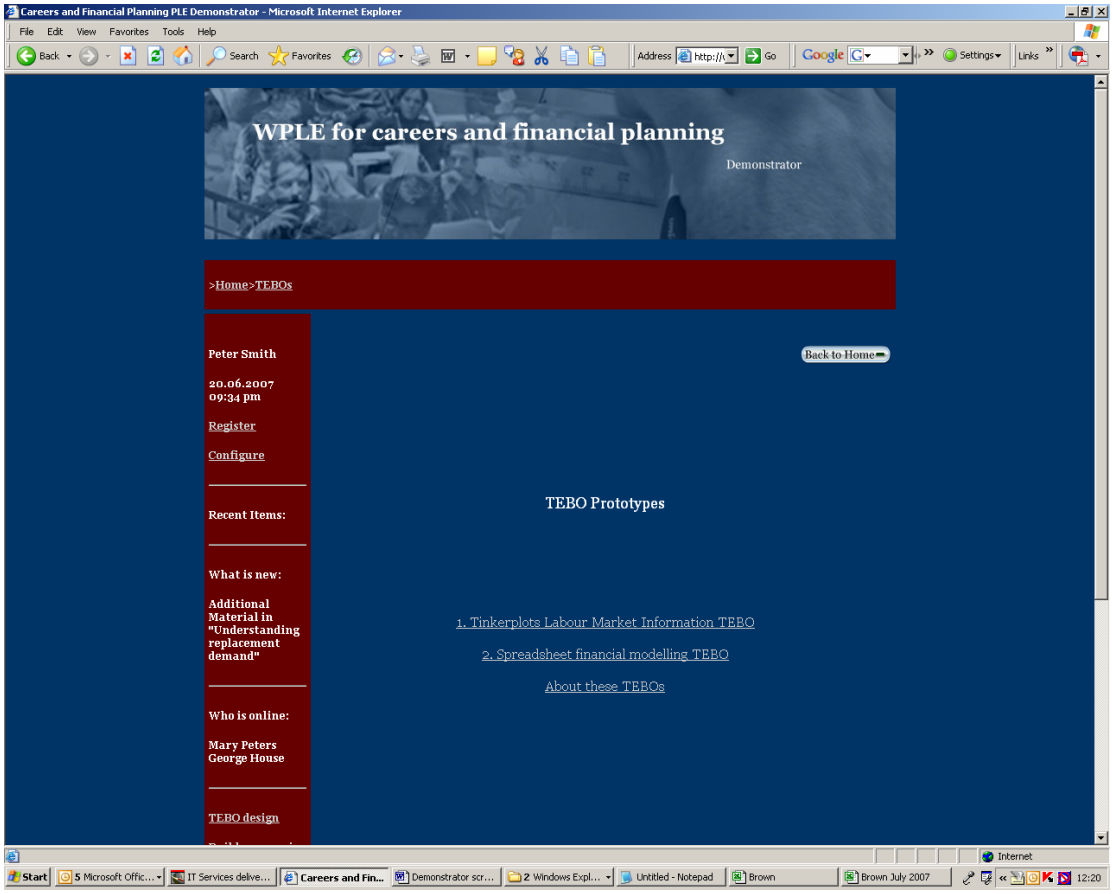


Fig. D6. Choosing ‘TinkerPlots LMI TEBO’ to investigate further how the individual fits in aggregate LMI data

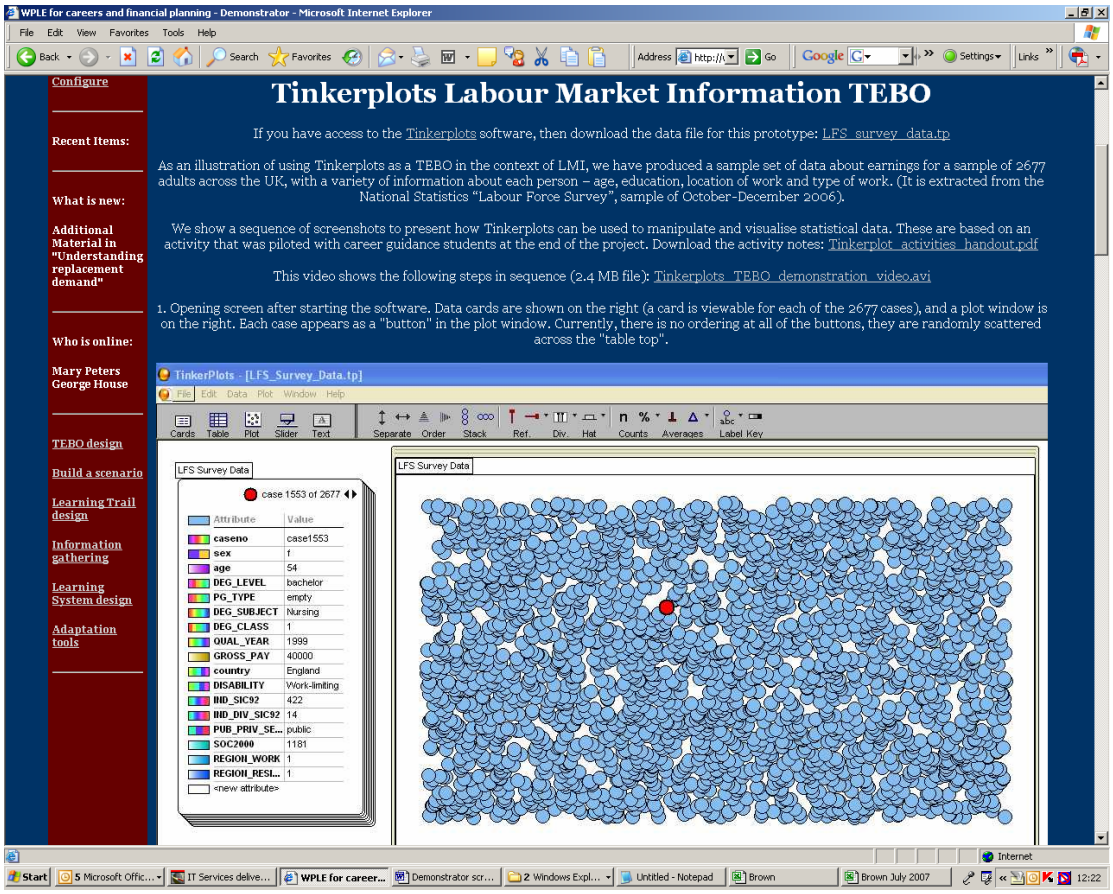


Fig. D7. Choosing ‘TinkerPlots Demonstration video’ to get an overview of how the program works

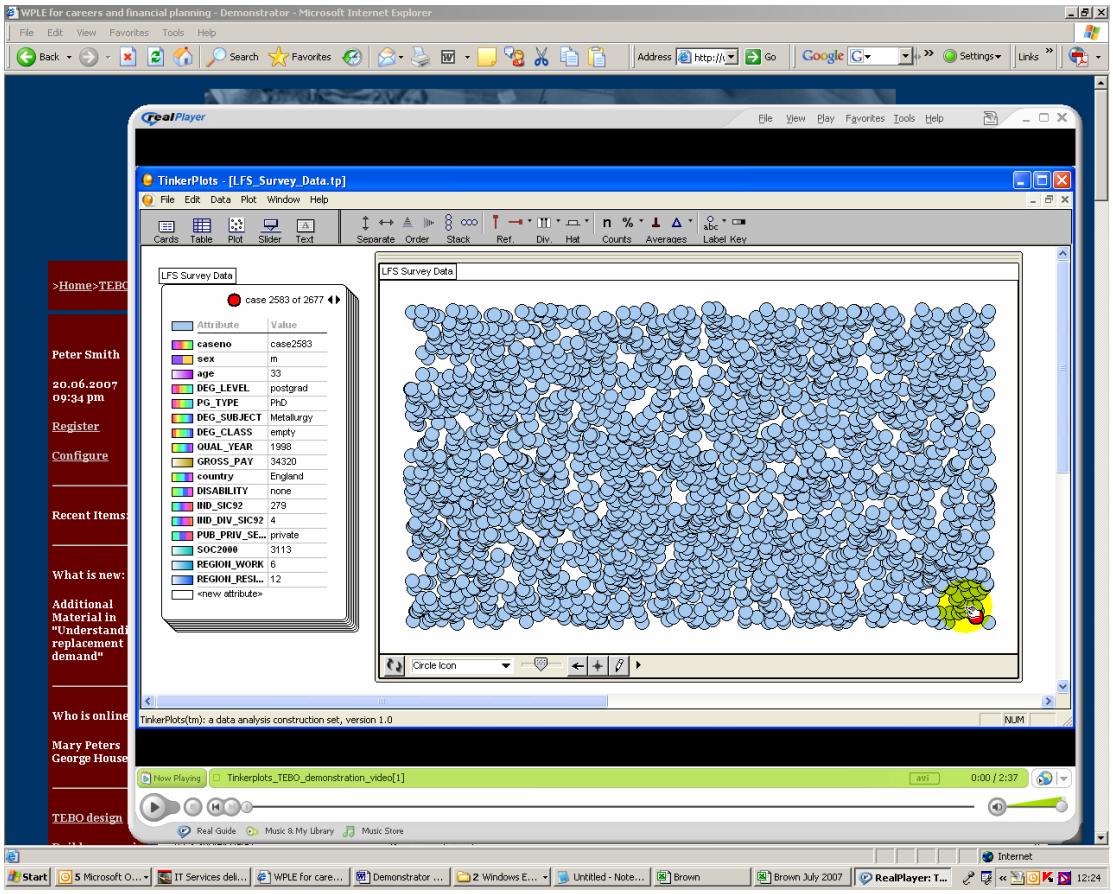


Fig. D8. After watching the video continuing onto second screen of ‘TinkerPlots LMI TEBO’ in order to look at the range of salaries in the data

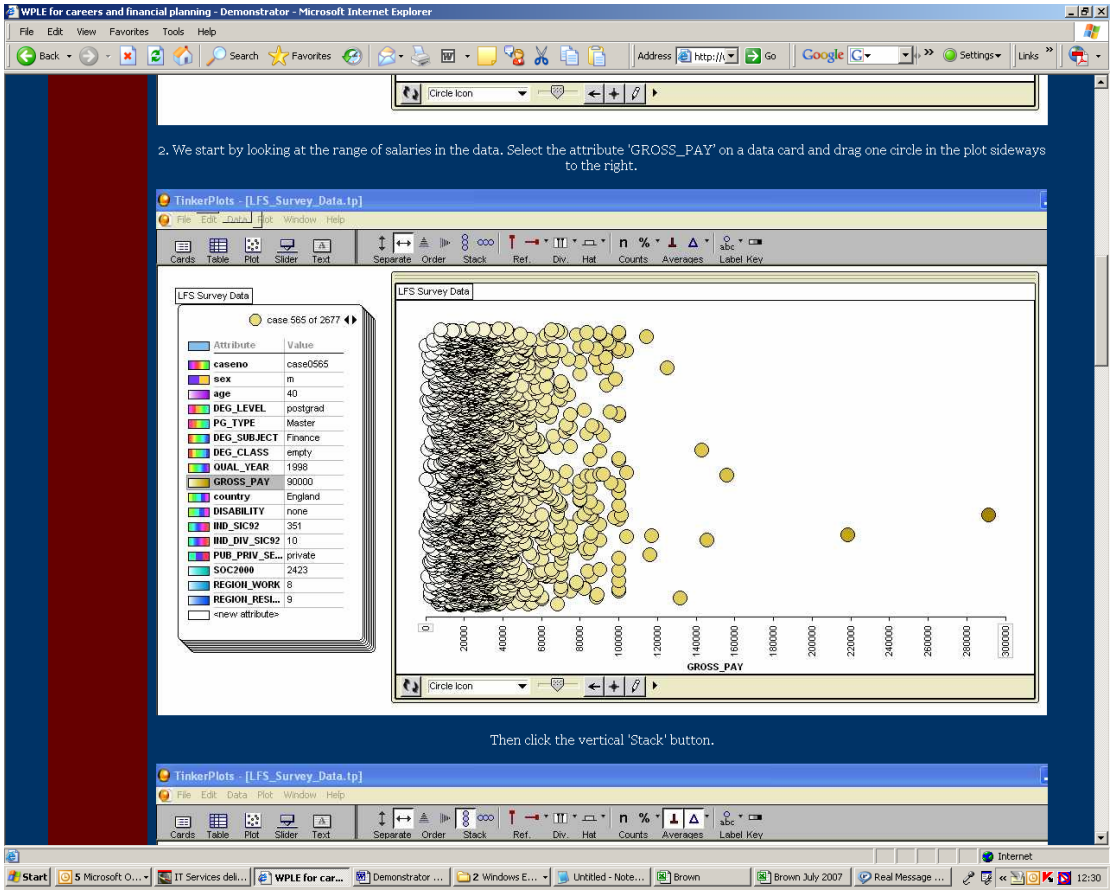


Fig. D9. Continuing onto the third screen of ‘TinkerPlots LMI TEBO’ showing what happens after clicking the stack button and getting a histogram showing the distribution of salaries

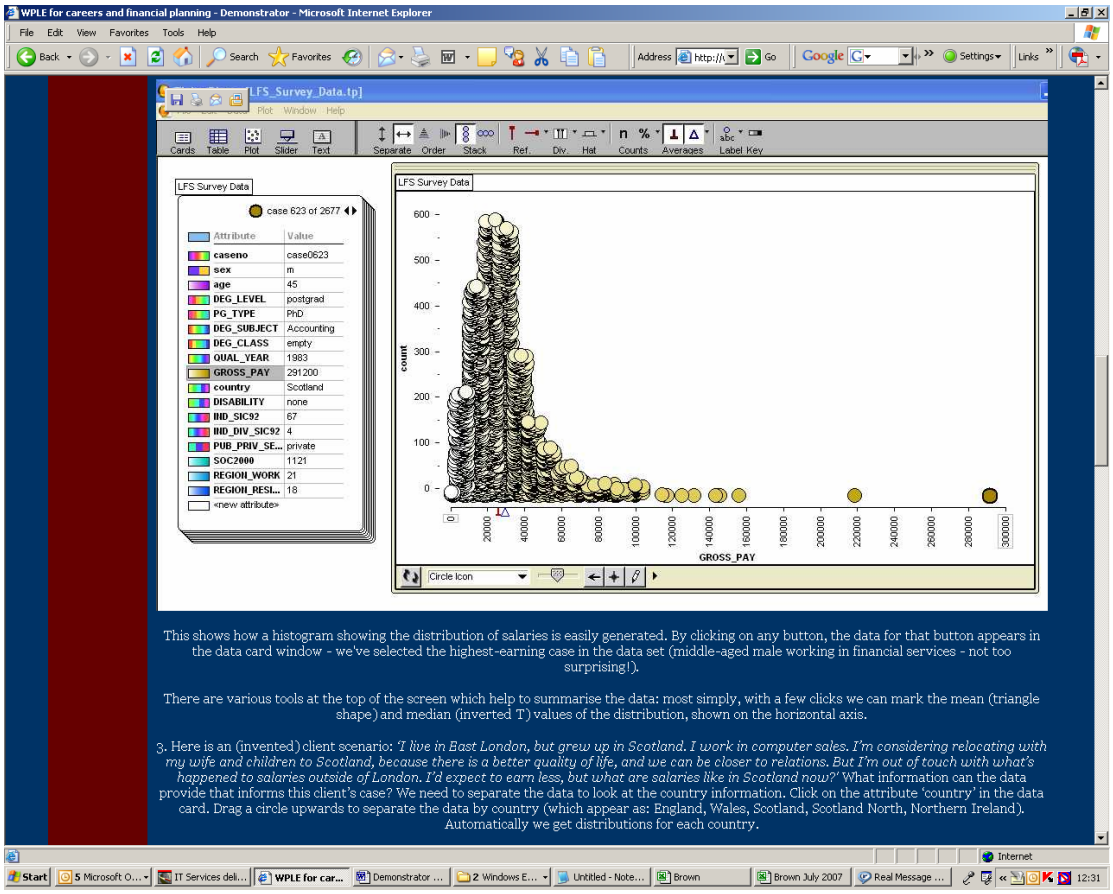


Fig. D10. Continuing onto the fourth screen of ‘TinkerPlots LMI TEBO’ showing the distributions of salaries for each country

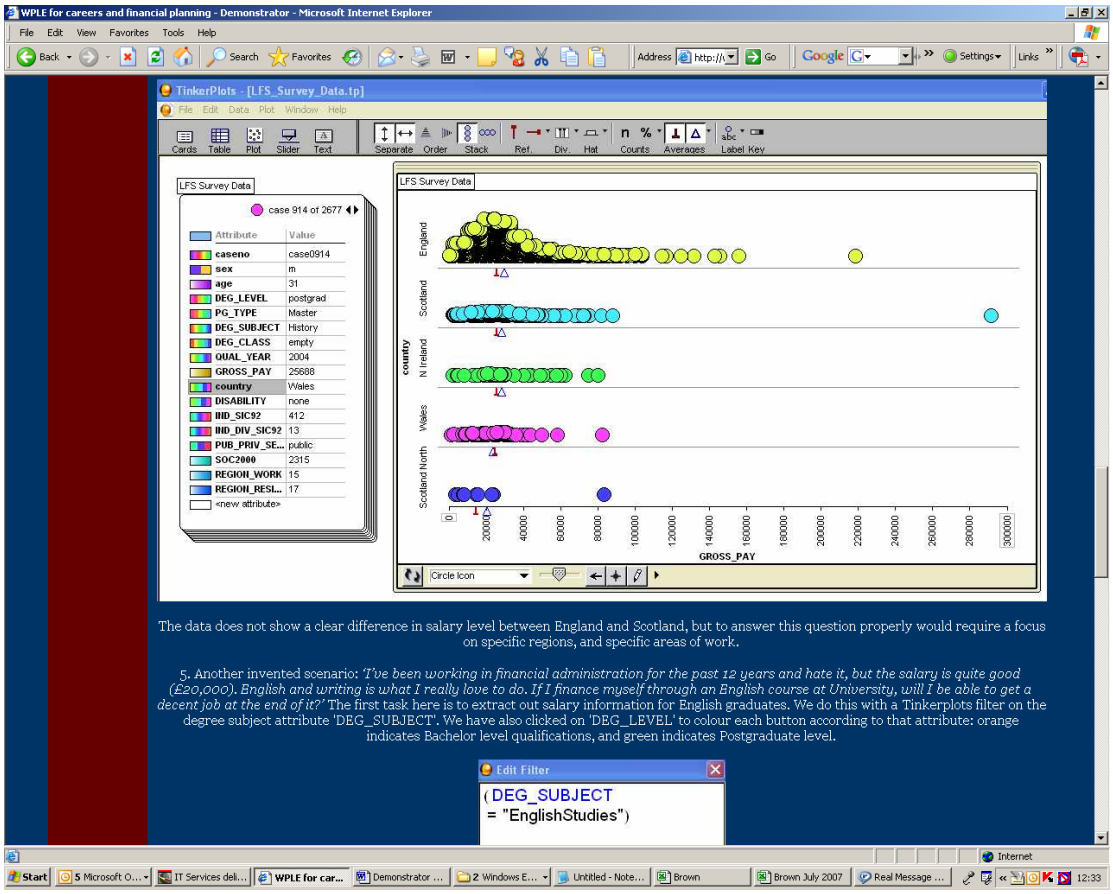
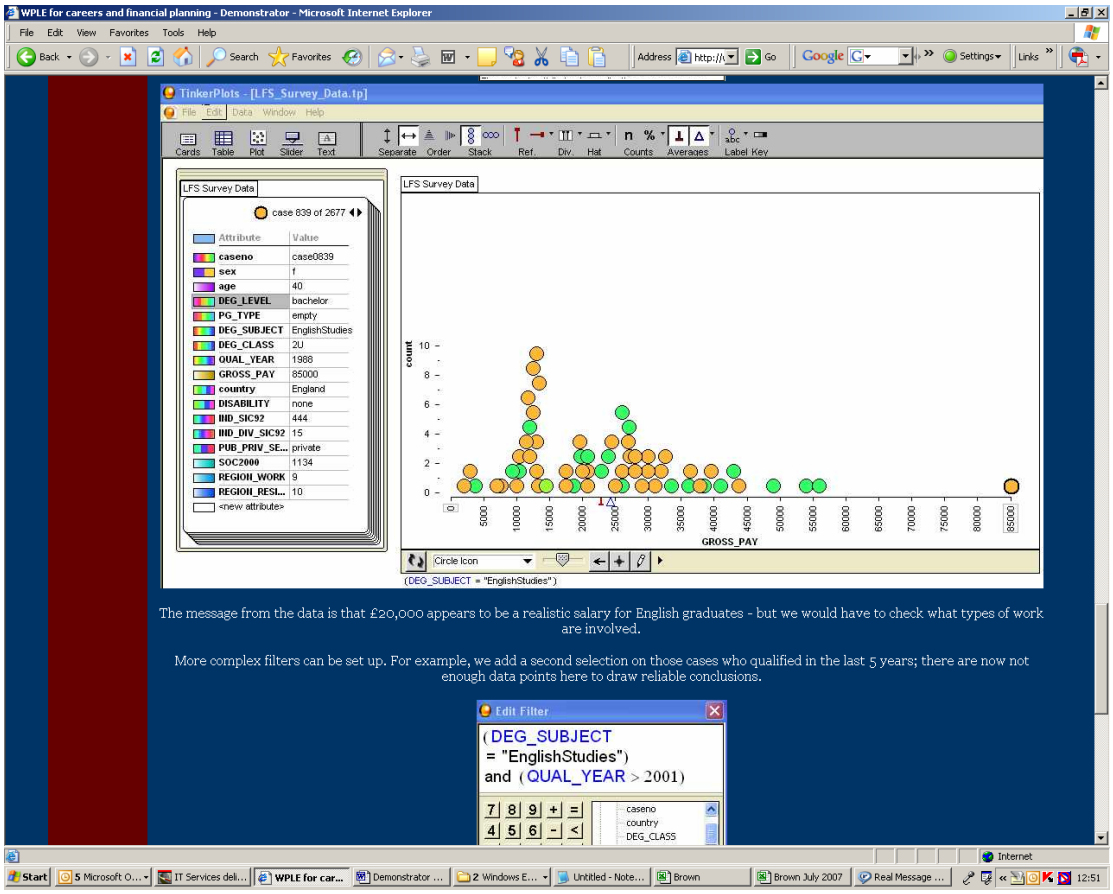


Fig. D11. The fifth screen gives the answer to the query about whether it would be possible to match the existing salary



Appendix E:

ESRC/EPSRC TEL Phase 2 proposal: submitted July 2007 Reference: ES/F030657/1

Design of a technologically enhanced learning system to support the development of an innovation community for guidance practitioners

Applicants

Role	Name	Organisation	Division or Department
Principal Investigator	Prof. Alan Brown	University of Warwick	Institute for Employment Research
Co-Investigator	Prof. Richard Noss	Institute of Education	Maths, Science and Technology
Co-Investigator	Prof. Alex Poulovassilis	Birkbeck College	Sch of Computer Sci & Info Systems
Co-Investigator	Dr. Jennifer Bimrose	University of Warwick	Institute for Employment Research

Case for support

Research aims:

- To design a technologically enhanced learning system to support the development of an innovation community for guidance practitioners
- To facilitate the visualisation, consolidation and transformation of learning of technical communicative skills for guidance practitioners through the use of technologically-enhanced boundary objects (TEBOs)
- To transform the learning, development and practice of adult guidance so to support adult learning and skills development (in line with the Leitch Review, 2006).

Research outcomes - improvements in learning outcomes will be at three levels:

- Guidance practitioners: higher quality, more effective learning in order to transform practice
- Organisational learning for policy actors and guidance services as to how to develop and sustain an innovation community
- Transformed adult guidance will lead to more effective learning and development of clients using the service.

Context: building on the success of our TEL 1 development project

This proposal builds directly on the success of our development project commissioned in the first round of TEL funding: 'Workplace personalised learning environments for the development of employees' technical communicative skills'.[13] That project resulted in a consensus between policy actors, practitioners, trainers and researchers on a strategy for development and a design for a personalised learning environment (PLE) to support the development of Technical Communicative Skills (TCS) for guidance practitioners.[14] With support of these users we are currently taking this work further in developing a prototype system. We will site this within the learning community for guidance practitioners we have previously developed (National Guidance Research Forum: NGRF www.guidance-research.org) (Brown *et al*., 2005). However, there is still a formidable multi-disciplinary learning challenge and that is whether we can support this community to move from focusing upon best practice and knowledge stewarding (organising, managing and stewarding a body of knowledge concerning TCS in career and financial planning) to becoming an innovation community – that is, one that create breakthrough ideas, knowledge and practices (Archibald & McDermott, 2006). The key points about an innovation community are that it is emergent, adaptive and should lead to fundamental changes in work practices. One outcome of the proposed project will be that guidance practitioners will be able to visualise, analyse and utilise labour market information (LMI) in new ways in the guidance process they offer for their clients (Bimrose *et al*., 2006; Bimrose & Barnes, 2006). However, beyond influencing those practitioners directly involved in the project, there will also be a strategy to engage policy and practice communities more widely at both local and national levels and to develop an innovation community.[15] The direct community support in the implementation of the PLE means that here we are only seeking funding as a smaller project, building on our innovative exploratory work. A 'lightweight' PLE system, making use of some prototype TEBOs, will be developed in collaboration with the community as a whole before this project starts: that is, consolidating our work in developing a knowledge stewarding community. The aim of this project will therefore be to examine the extent to which technologically-enhanced learning system can support the development of an innovation community to enhance learning, development and practice in guidance.

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[13] For full details see attached report on the project. During the development project the research team had discussions with members of HM Treasury, DfES, Learning and Skills Council, UfI LearnDirect, SSDA, sector skills councils and Institute for Career Guidance (ICG). The DfES and LSC have since been restructured, but our contacts will continue to be involved in this area in DIUS and the restructured LSC.

[14] This consensus is particularly important given that the announcement of a universal approach to adult guidance with a stronger labour market focus is imminent. This means that the development of TCS has moved from a desirable requirement to a fundamental component in the development of practitioner expertise.

[15] The project will also work with national practitioner bodies such as the Institute for Career Guidance 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. The network of careers guidance training providers will involve the Universities of East London; Glamorgan; Strathclyde and Ulster. It is particularly important to get representation from all parts of the UK as the guidance systems vary significantly between jurisdictions.

Illustrative research questions linked to the research aims:

TEL system design:

- How can the System be made adaptable to the needs of practitioners?
- How effective is the System in improving learning outcomes for guidance providers, practitioners, trainees and clients?
- What are appropriate communication/discussion facilities for the System to provide in order to foster and sustain interaction and innovation?

Technologically enhanced boundary object (TEBO) development:

- How far does the use of TEBOs facilitate the visualisation, consolidation and transformation of learning of TCS for guidance practitioners?
- How do individual practitioners interact with the learning resources of the envisaged System, particularly TEBOs and other resources?

Transformation of the learning, development and practice of adult guidance:

- How do communities of practitioners interact with the learning resources of the System, and with each other?
- How does a community focused upon best practice and knowledge stewarding become an innovation community?

Research activities to be undertaken:

TEL System development

- leveraging the outcomes of the PLE Development project and subsequent development work: system will include 'lightweight' PLE plus prototype TEBOs with interaction, search, communication/discussion functionality; iteratively refine and enhance the system throughout the life of the project;
- Identify what are appropriate TCS learning outcomes for users of the System;
- Design learning activities to assess learning outcomes for pilot users;
- Investigate how effective the system is in improving learning outcomes;
- Investigate whether recurring patterns can be detected in the authoring process for TCS learning activities;
- Implement an appropriate pedagogic model for TCS development;
- Analyse the usability of the System and the modes of interaction of practitioners in order to accomplish specific learning activities;
- Design and develop enhanced techniques for adaptation to needs of practitioners and clients: including the ability of user groups to adapt the system environment itself and the configuration of resources used;
- Development of filtering and recommendation tools for use of particular resources to specific practitioners in the construction, use and adaptation of scenarios using TEBOs in contexts meaningful for them.

Technologically Enhanced Boundary Object (TEBO) development

- Identify the key set of TEBOs needed to support the development of TCS for guidance practitioners (understanding LMI and financial modelling/planning);
- Identify the *conceptual* challenges in interpreting the output of TEBOs: graphs; labour market predictions; charts; employment data; financial models etc.;
- Identify the connected *communicative* challenges in identifying the merits and disadvantages of different choices according to different personal needs, and communicating personalised advice based on LMI and financial planning?
- Identify the appropriate pedagogic scenarios for the use of TEBOs in learning TCS within a personalised/adaptive learning system;
- Support practitioners in how to visualise, analyse and utilise labour market information in new ways in the guidance process they offer for their clients.

Development of an Innovation Community to transform learning, development and practice of adult guidance

- Support organisational learning for policy actors and guidance services as to how to develop and sustain an innovation community;
- Support the creation of breakthrough ideas, knowledge and practices;
- Design learning activities to assess learning outcomes involving communities of users and investigate the effectiveness of the system in improving these;
- Investigate effects upon guidance practice and work with clients.

Research Methods:

For system development we will employ interviewing and observation protocols, as well as data logging facilities embedded within the System itself and data mining techniques. We will also investigate whether, and to what extent, knowledge of TCS learning can be formulated in a reusable manner. If recurring patterns of interaction of practitioners with the system occur, we can design facilities by which these can be explicitly represented and stored as reusable 'learning trails' within the system's repository of learning resources. For the **technical design and programming of the set of TEBOs**, users will be involved in all stages of an iterative design process as it is important to understand the context of user. In developing the set of TEBOs we will adopt a phased approach, with different TEBOs being in early, mid and late development stages as the work progresses. The software basis for the TEBOs will be one of the 'rich internet application' software platforms, such as Adobe Flex or Java.[16] For the **innovation community development** the challenge will be to convert information to actionable knowledge at different (individual v. organizational) systemic levels and to build a learning culture with commitments to learning, knowledge development, issue orientation and continuing professional development with embedded institutionalized learning mechanisms (Popper & Lipshitz, 2000) .

[16] We are confident of the technical capability of such platforms, however their rate of evolution is very fast and we have deferred detailed consideration of platforms to a later stage of the research design.

Relation to the competition's substantive research challenges:

The major focus is upon **productivity**: achieving higher quality and more effective learning by:

- Exploiting the rich potential of TEL systems to support learning through the visualisation, consolidation, representation and transformation of knowledge;
- Reshaping adult guidance itself: this is seen as a key component of the Leitch Implementation Plans (Leitch, 2006) and clearly also links to three of ESRC's key research challenges: 'Succeeding in the global economy'; 'Understanding and shaping individual decisions' and 'Education and life chances'.

There is a degree of **personalisation** too in the overarching learning system through the development of a Personalised Learning Environment.[17]

Relation to previous research:

The proposed design of the **learning system** will be underpinned by the results of the TEL 1 development project (see attached report); work on adaptive and personalised systems development (Brusilovsky & Nijhawan, 2002; Brusilovsky & Peylo, 2003; Frias-Martinez *et al*. 2005; Keenoy *et al*., 2005; Magoulas and Chen 2006 a, 2006b; Magoulas *et al*. 2003, 2005) and work on PLEs (Attwell, 2007; van Harmelen, 2006; Wilson *et al*., 2006). The system itself will be designed in accordance with the approach of Spiro *et al*. (1988) who used cognitive flexibility theory to explain how to support effective learning in complex domains.[18]

The value of multiple representations of information, including dynamic visualisations of data and relationships has been well documented, along with a recognition of the importance of a sound underpinning model of the basis for conceptual understanding (Ainsworth & Th Loizou, 2003; Hegarty, 2004; Lowe, 2003, 2004; Ploetzner & Lowe, 2004; Schnotz, 2002; Chandler, 2004; van Someren *et al*., 1998; Narayanan & Hegarty, 2002).

The **development of an innovation community** builds upon earlier research and development at the University of Warwick on guidance community development (Brown *et al*., 2002, 2005, forthcoming); knowledge communities (Scarbrough and Swan, 2002); knowledge evolution and representation (Ewenstein & Whyte, 2005; Whyte & Ewenstein, 2005; see also Knorr Certina (2001) on visual representations as 'artifacts of knowing' characterized by an 'unfolding ontology'); and how to support the development of innovation communities (Archibald & McDermott, 2006). In community development it is important to support individual and organisational learning (Popper & Lipshitz, 2000), build virtual communities (Allen *et al*., 2005), and offer human support to help deal with complexity and build commitment (Spiro *et al*., 1988).

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[17] The design of the PLE was facilitated by TEL 1 development project funding, but the continuing development of the PLE is currently being supported by two adult guidance providers.

[18] Spiro et al. (1988) stressed the need to avoid oversimplification; value multiple representations; value case studies; define meaning as use; prefer flexible schemata; seek interconnectedness; value human support systems to help deal with complexity.

Contribution to theory development, interdisciplinarity, user engagement, capacity-building and programme as a whole:

The partners have separately made contributions to development of TEL systems; development of TEBOs and TEL-supported knowledge and community development, but the contribution to be made here is to draw these strands together in an integrated inter-disciplinary, technologically enhanced and theoretically-informed approach to the development of an innovation community.[19] User engagement at all stages of the research process is fundamental to our approach and we are building on the full engagement of significant policy actors (DIUS; SSDA; UfI Learn Direct; LSC); training providers; guidance services; professional organisations (ICG) achieved in the TEL 1 project and in the continuing support for the current learning community (NGRF) for guidance practitioners. With the substantive contributions the partners have already made to TLRP through projects in earlier phases (TEL 1; TmL) and the principal investigator (Brown) in his role as TLRP Associate Director (workplace learning and professional learning) it is clear that the team will engage fully with the programme as a whole. Additionally, however, the substantive focus of this project will contribute to the broader programme in two ways. First, the focus upon how to support a community in a shift towards becoming an innovation community, able to transform learning, development and practice, could provide valuable lessons both for TLRP in capacity-building for the broader educational research community. Secondly, the context of changing adult guidance practice itself contributes a missing part of the mosaic of how to support the learning of adults more generally and, as such, makes this project valuable to TLRP at four inter-related levels: with contributions to TEL; professional learning; community development; and adult guidance.

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