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Final Report

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Personal Learning Environments

Final Project Report

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Executive Summary

The Personal Learning Environment (PLE) project has sought to investigate the impact of emerging technologies on e-learning provision from a variety of perspectives ranging from institutional organisation to pedagogical practice. The project comprises two deliverables: a detailed report which of our investigation which specifies a reference model (domain map) as well as details the scope and nature of our investigation; secondly, we have produced a PLE prototype (PLEX) which embodies the principles of the reference model and provides a practical example of the concepts identified.

The PLE project has been an opportunity to explore some fundamental territory in the e-learning domain. This exploration has been timely in the fundamental technological changes brought about by the transition to “Web2.0” and the rise of service oriented architecture, together with a widespread recognition of the problems inherent in current approaches to e-learning from the perspectives of life-long and life-wide learning. It has also been an opportunity to further existing work on the development of service oriented architecture within e-learning, deepening work on the implications of and extensions to the JISC e-Framework.

The technical achievements of the project have been used both to ground the theoretical work in practice, and as a useful exploration of possible tools within the PLE domain. The development of PLE prototypes from a number of different technical vantage points (portal and rich-client) has afforded the exploration of the merits of these different perspectives.

The project is rich in recommendations for further work. This is itself is a testament to the theoretical grounding that the investigation has established, and the fact that a clear path for future coordinated development can be presented. At the same time, whilst in the intervening period of the project, (and partly through the dissemination activities attached to the project) greater agreement is being reached as to the technical constitution of the PLE, the question of ‘what a PLE is’ still evokes a wide variety of descriptions. This in a sense is in the nature of a very ‘personal’ technology. In our work, we have not sought to produce a ‘description’ of the PLE – for an effective description which covers all its aspects would be impossible. Rather, we have created a ‘coordination of different descriptions’, showing how despite differences of opinion, the essential elements of the technology can be specified and an effective plan for its further development can be formulated.

Background

The Personal Learning Environment has been an emerging theme of discourse in the e-learning community for some time. It has emerged from a variety of different sources, including the body of opinion which has grown in the light of experience of e-learning developments to date (VLE, ePortfolio, etc) and acknowledges some of the weaknesses of existing e-learning provision. It has also emerged from the discourse related to new technologies and particularly the impact of service-oriented architecture, and the emergence of the concepts surrounding “Web2.0”. These critical and technological factors have combined to create a general movement towards the area of Personal Learning Environments, driven in particular by the desire to meet the needs of Life-long and Life-wide learning and eliminate the barriers of access to learning opportunities.

This discourse has implications for the future provision of learning technology and the coordination of future projects. Therefore, it demands three fundamental questions:

- a. How do we characterise the Personal Learning Environment in a way that each of the diverse communities working in the space can situate themselves?
- b. How do we characterise the Personal Learning Environment so that an effective policy with regard to its adoption, and the organisational changes that emerge from it can be formulated?
- c. What future work needs to be done to forward the idea of personal learning environments?

In addressing these questions, we have sought to extend the basic principles of the JISC e-framework, in highlighting the importance of service oriented architecture in the removal of redundant functionality which characterises so much of the existing monolithic e-learning infrastructure. The key advance of the PLE is to situate the coordination of technology with the learner rather than with institutions (if the original conception of the e-framework was directed at the creation of ‘personalised institutional systems’ out of a fabric of pre-existing services, the PLE seeks individualised systems created as a coordination of personal services).

Much of the PLE project has therefore been directed at investigating the operationalising of existing web services which are currently available under the banner of ‘web2.0’ and exploring how they might be effectively coordinated for use in a learning context.

Aims and Objectives

The PLE project aims to establish a clear framework for future coordination of learning technology by taking account of emerging technologies, through the production of a reference model which in turn entails the negotiation of a theoretical framework.

Its objectives have been

1. Define the scope of the term Personal Learning Environment, including distinguishing it from the term Personalized Learning Environment. This will involve consulting with all initiatives and individuals who are active in this area.
2. Propose a rich list of user requirements for any system to be included within this definition
3. Identify the technical requirements for such a system, addressing different implementation scenarios (client or server based, client-server or peer-to-peer) and addressing issues of integration into the eLearning Framework
4. Produce a reference model and specification for a Personal Learning Environment that will elaborate on how the PLE can work within a service oriented framework:
5. Evaluate potential technologies that can act as plug-in platforms for personal learning environments
6. Implement a reference pilot implementation of a personal environment using the Eclipse RCP
7. Integrate the CETIS Enterprise Web Services toolkit as a plug-in as an example of the integration of web-service toolkits
8. Develop a web-service interface that enables information to be exchanged between two concurrent applications based on Chandler
9. Make the software developed as a open-source project on SourceForge

Methodology

The PLE project has been both a technical development project and a research project resulting in the production of a theoretical framework and a reference model. Whilst a coordination has been achieved between these different aspects, the nature of the project has been fundamentally multi-methodological.

Research Methodology

The research methodology for the PLE reference model has itself been multi-layered. It has made use of a number of different methodological approaches. Within the context of a literature review, it has sought to summarise the discourses which feed the general discourse on personal learning environments. Within the context of an investigation of user behaviour, we have used Alexander's 'Pattern Language' methodology to uncover patterns inherent in the ways in which current technologies are used. Within the context of the construction of a deep theoretical framework to situate the PLE, we have sought to uncover the positions of philosophers and cybernetics to situate our arguments for the PLE.

These different research angles comprise different 'descriptions' of the PLE problem domain. Within our work, we have sought to achieve a consistent coordination between these different layers of description. By adopting this approach, we have been able to embrace the diversity of possible interpretation of 'what the PLE is', whilst at the same time we have been able to specify in some detail the technological components of PLE technology, to distinguish PLE technology from non-PLE technology and further distinguish the discourse on Personal Learning Environments from that of 'Personalised Learning'.

Technical Design Methodology

The technical design methodology for the PLE prototypes has depended to some extent on the theoretical work (particularly the identification of Patterns). This work has informed the actual design and functionality of the prototype. The software which we have written as part of the project is characterised within our work as a 'toolkit'. This should not be confused with the 'personal learning environment' per se. The toolkit is a coordinating application which allows for the combination of a variety of services. The services which we have integrated into this toolkit are already in existence. However, some services which are identified by the reference model do not yet exist (particularly workflow and activity management services). These service descriptions form the basis of our recommendations for further work.

Rich Client application versus Portal-based architecture

The nature of a personal learning environment does not prescribe any particular technical manifestation for the toolkit. The prime criterion is for a tool which can coordinate services. Therefore we sought to implement two types of toolkit within the project: a rich-client application and a portal-based web application. Both these perform the role we identified for a Personal Learning Toolkit, although the rich-client application was more extensively developed than the web application (owing to some limitations in portal technology).

Evaluation Methodology

The validity of the reference model we have produced will clearly only reveal itself over time. However, within the timescale of the project, we have evaluated the effectiveness of our characterisation in a number of ways. Firstly, the degree to which the practical implementation reflects the theoretical framework is an important factor. Secondly, the extent to which use-case scenarios generated by the model can be considered 'reasonable' and consistent both with the general discourse of personal learning environments and the theoretical background. Thirdly, the extent to which differences with the characterisation of the PLE may be clarified through use of the theoretical framework we have produced is also an indication of its merit. Fourthly, we can gauge the general direction of technological developments and measure them against the predictions of the model.

Implementation

Phase 1

Phase 1 of the project comprised a broad review of literature and technology comprising three fundamental strands. Firstly there was a technological strand which surveyed existing technology. Secondly, there was a thematic strand which examined the larger-scale implications of the PLE concept and reviewed current discourse. Thirdly, there was a deeper theoretical strand which sought to build philosophical and cybernetic characterisations of the work.

The wide-ranging nature of these investigations was conducted and coordinated through the use of a wiki, with the aim that eventually a coordination between the different strands of investigation would be achieved.

Phase 1a – Technical Analysis

Throughout the early stages of the project, a significant investigation of currently available tools was conducted. The work on this was documented on a wiki shared by the project team. Technologies were reviewed which had a relationship to the general domain of the PLE – whether as constituent services, or as integrating agents of a similar type to the PLE.

This work fed through both into the theoretical part of the report, as the challenges and types of behaviour of users using these new tools became more apparent, but it was also an important part of the technical evaluation for suitable platforms to develop a PLE toolkit.

With this latter task, the decision was taken early on to develop both a portal-based solution and a rich-client solution. Eclipse Rich Client was chosen as the platform of choice for the latter (owing to existing expertise, and ease of development), and LifeRay was chosen for the former.

Phase 1b – Emergence of broad thematic issues

It was clear that the PLE had significant social implications with regard to the organisation of education, and their impact on educational institutions. Not least, this discourse reflected the discourse of those who have been critical both of the educational system in general and current e-learning provision in particular. Using the wiki as a platform, an exercise was begun whereby the broader implications of

the impact of the PLE could be listed and explored. These ranged from the technological impact, to institutional impacts and pedagogical impacts, and also considered issues relating to the transition from existing centrally-controlled technology to the PLE.

Phase 1c – Formulation of a theoretical Framework¹

In parallel with the work on technology, a review of philosophical literature on the phenomenology of tools and usage was undertaken. From this work, and from the basic underlying technical investigation (including reflection on personal experience with the tools), a few fundamental concepts were established which guided both the future technical development and further theoretical development. Foremost amongst these was the establishment of the separation of conventional ‘tools’ into instrument and service. Extending the VLE work of Britain and Liber², and building on the phenomenological approach of Winograd and Flores³, the separate concepts of instrument and service were envisaged to have a particular cybernetic representation which had implications for personal cognitive organisation. This basic model needed fleshing-out, but the establishment of these basic concepts was a guide to clarify thinking both in the later stages of the building of a theoretical framework and in the later stages of technology design. In particular, these basic concepts were used as a distinguishing mark between PLE technologies and non-PLE technologies.

Phase 2 – Emergence of Patterns⁴

Familiarity with tools emerging in the space led to a more detailed examination of the types of user interaction associated with such tools. For this, Alexander’s Pattern Language methodology⁵ was used as a way of structuring the patterns of usage of user engagement with the tools observed. The construction of a pattern map would then be used as a touchstone for the specification of services within the new PLE.

Phase 3 – Making connections between different levels of investigation

The three strands of investigation all achieved relative maturity at about the same time. At this point, a programme of dissemination began which necessitated the joining-up of the different strands of investigation and the contextualisation of a reference model. The biggest challenge was to find an effective way of communicating the work we had done. Thus it was at this point that the stratified approach was established, and the basic idea of coordination between different levels of description.

Phase 5 – Dissemination and Review

The programme of dissemination consisted of the production of a number of conference papers^{6 7 8} and presentations. Chief amongst these was the PLE experts

¹ http://wiki.cetis.ac.uk/Ple/Report#Executive_Summary_3

² Britain and Liber (2004) A Framework for the Pedagogical Evaluation of eLearning Environments: JISC Report http://www.cetis.ac.uk/members/pedagogy/files/4thMeet_framework/VLEfullReport

³ Winograd T. & Flores F. (1987), “Understanding Computers and Cognition - A New Foundation for Design”, Addison Wesley Publishing Inc, Reading, USA

⁴ http://wiki.cetis.ac.uk/Ple/Report#The_establishment_of_a_pattern_language

⁵ C. Alexander, S. Ishikawa, M. Silverstein, M. Jacobson, I. Fiksdahl-King and S. Angel, *A Pattern Language* (New York: Oxford University Press, 1977)

⁶ Johnson, M; Liber, O; Beauvoir, P; Wilson, S; Sharples, P; Milligan, C (2006) “Mapping the Future: The Personal Learning Environment Reference Model and Emerging Technology” ALT-C conference proceedings

⁷ Johnson, M; Liber, O; Beauvoir, P; Wilson, S; Hollins, P; Milligan, C (2006) “Towards a reference model for the personal learning environment” Ascalite Conference (2007) - forthcoming

⁸ Johnson, M; Liber, O; Beauvoir, P; Wilson, S; Hollins, P; Milligan, C (2006) “The personal learning environment and the institutional divestment of technology” Ascalite Conference (2007) – forthcoming

conference⁹ organised in Manchester to an invited audience where the elements of our investigation were presented and discussed.

Outputs and Results

Outputs

Reference Model

The PLE reference model¹⁰ exists as a conceptual map of components which comprise a personal learning environment. The model serves three purposes:

- a. to provide a basic touchstone for the design of PLE services and toolkits
- b. to provide a framework whereby existing technologies may be assessed for their PLE-compliance
- c. to provide terms of reference for the e-learning community with regard to the characterisation of the PLE.

These purposes are inter-related: PLEX¹¹ was designed against the principles of the reference model, and demonstrates clearly the power of a Personal Learning Toolkit. In embodying the principles of the model, the similarities between PLEX and other developments (like Flock¹²) are also apparent. Furthermore, the model has been used for discriminating between different software projects within the PLE space (for example, identifying the differences between Netvibes¹³ and Yahoo widgets¹⁴). The terms of reference provided by the theoretical framework have also been useful both in clarifying some issues relating to the PLE (for example, is an operating system a PLE?), and establishing a more stable foundation for discussion.

Within the life of the project, the reference model was presented to groups in various settings (for example the experts meeting, ALT-C), and its reception has been a useful guide to its efficacy as a reference point for discussion, design and critique.

The Report

The PLE reference model is part of the PLE report, and relies on the identification of patterns and key philosophical and cybernetic concepts for its realisation. These philosophical and cybernetic ideas are discussed at some length within the report. As greater understanding of the technical constitution of the PLE becomes more widespread, we argue that these philosophical and cybernetic issues will become a highly significant aspect of our work. The purpose of our theoretical investigation was to establish as clearly as possible a cybernetic and philosophical characterisation of social ontology, for we argued that without a broad view of social ontology, the intervention of the PLE could not be situated, nor could its impact be evaluated.

Because of the fundamental importance of this social ontology in our conceptualisation of the PLE, emerging evidence of the validity of the predictions of the PLE reference model also present some indication for the validity of the social ontology that is articulated beneath it. Whilst we acknowledge that we have only scratched the surface of this domain, we do aim to highlight the issue of social ontology and modelling within the discourse of e-learning as an effective approach

⁹ PLE Experts Meeting, Manchester 2006

¹⁰ <http://wiki.cetis.ac.uk/Ple/Report>

¹¹ <http://www.reload.ac.uk/plex> and sourceforge http://sourceforge.net/cvs/?group_id=76357

¹² <http://www.flock.com>

¹³ <http://www.netvibes.com>

¹⁴ <https://widgets.yahoo.com>

for the creation of new technological interventions, building on the success of similar approaches adopted by Winograd and Flores.

PLEX

PLEX is a working prototype of a Personal Learning Toolkit. It allows the user to connect to services for reading RSS feeds, blogging, searching learning opportunities (including XCRI), and organising social groups (including groups established through institutional student databases), resources and activities. PLEX embodies the principles of the reference model, including an architecture driven by feeds and conduits, and the provision of a small set of instruments for the accomplishment of a wide variety of activities. It is designed to fit the model of a learner who is engaging in multiple communities of practice, affording facilities for a learner to manage different 'personas' which might engage in those communities of practice, and provide facilities whereby a learner's social network, the activities that the learner is engaged with, and the resources that a learner may require may be coordinated with the learner's various personas.

PLEX embodies the fundamental principle of the PLE in affording two fundamental types of learner action. Firstly, we see learners engaging in actions which fulfil commitments to personal organisation and self-maintenance (for example, the organisation of a social network, or resources). Secondly, we see learners engaging in actions which fulfil social commitments to external agencies, whether courses, teachers, or other people. Within this second domain, we situate the traditional learning activity, together with the performance of acts which meet other social commitments. These two types of action are inter-dependent, and the very principle of PLEX is to ensure that those actions relating to personal organisation have a beneficial effect on those actions relating to external commitments (and vice-versa).

Results and Evaluation

The results of this project amount to a clear direction for future coordination of learning technology from a PLE perspective. The validity of our conclusions can be measured in a number of ways, although their true value will only be apparent over a longer timeframe. Within the scope of the project itself, there are a number of aspects of our work which can serve as indicators of its internal consistency. These include:

1. The internal consistency between the different strands of investigation
2. The 'reasonableness' of generated scenarios¹⁵ from the PLE reference model

In addition to these internal measures, we can also point to recent technological developments which reflect the predictions of the PLE reference model, and in particular reflect the architectural composition of PLEX.

With regard to the internal consistency of our work, we have produced three strands of investigation and we can demonstrate the degree of coordination between these different strands. For example, the thematic strand explores criticisms of current learning technology; these criticisms are situated within a cybernetic characterisation in the theoretical part of the work which acts as an explanatory framework for those issues identified. This same cybernetic characterisation can also be used to situate the emerging patterns of user behaviour with current technology identified through our pattern analysis.

Our use of the reference model for situating the 'PLE compliance' of currently available technologies, and as a model for the design of new PLE compliant toolkits

¹⁵ See http://wiki.cetis.ac.uk/Plc/Report#PLE_Scenarios_and_the_validation_of_the_PLE_model

has borne fruit not just in PLEX, but the same patterns of design can be witnessed in emerging software projects developed independently of the project. For example, Flock bears considerable similarity to PLEX in its seamless coordination of a variety of services and its adoption of the conduit/feed model. Netvibes too provides a powerful example of a web-based implementation of these facilities.

Outcomes

The objectives outlined in section 2 can be addressed as follows:

1. *The report has defined the scope of the Personal Learning Environment. In particular the reference model helps to define what is and what is not a personal learning environment.*
2. *The purpose of our methodological approach has been to specify a range of user-requirements. These requirements can be evaluated through the production of use-case scenarios.*
3. *The PLE reference model specifies the basic architecture of the PLE, together with a detailed specification of the services upon which it depends. Many of these services are already in existence, however new service specifications for workflow and activity management services (for example) detail those extensions to the current service provision which are required for the Personal Learning Environment to provide effective support to learners.*
4. *The reference model situates the PLE within the context of Service Oriented Architecture, and extends the principles of the e-Framework.*
5. *and 6. The PLEX prototype has explored the potential of Rich client development using Eclipse, producing a plug-in based architecture which meets the needs of a personal learning toolkit.*
7. *The Enterprise toolkit features as a component of the PLEX environment, allowing users to communicate with institutional student databases for the construction of groups of students.*
8. *This objective concerns interoperability, although after further investigation, it appeared that Chandler was a poor platform to support. However, with the integration of OPML within PLEX, a wide-ranging interoperability has been achieved.*
9. *Both PLEX and PLEX/W are open-source projects managed by Sourceforge.*

Conclusions

In the time since the project started, many developments within the PLE space have advanced considerably. It is to the considerable satisfaction of the PLE team that developments such as 'Flock' seem so closely-related to the PLE conception embodied in PLEX. This is a significant validation of our approach and the strength of

the framework that we have built. However, the emergence of these new tools within the Web2.0 sphere changes the technical landscape whereby recommendations for further work may be made.

The purpose of our technical development of PLEX was to situate the theoretical concepts of the model in a practical tool. This has been a highly successful strategy. However, the rich-client plugin architecture of PLEX must now be seen in the light of other (and possibly more appropriate) plug-in architectures of Mozilla Firefox, Flock, and the continuing developments of other projects like NetVibes. Such projects have a potential for market penetration which may supersede plugin architectures like Eclipse.

At the same time, the increasing ubiquity of OPML, RSS and other simple standards is increasingly establishing an environment where interoperability coordinated directly by users between different services is the norm. Thus, through OPML the coordination of services generated in Flock, can easily be viewed through other tools. Once again, this development is entirely consistent with the theoretical framework and the reference model.

Given this early evidence, then, we may conclude that the significant elements of our work are contained within the reference model and the theoretical framework, and that further independent technological developments are showing themselves to be within the expectations of that framework and can be situated comfortably within the reference model. Whilst it has been a fundamental component of our strategy for the production of the model, the development work situated around Eclipse may itself be eclipsed (!) by other developments that are ongoing in the web2.0 community at large.

Having said this, these new developments fall short of the specification of a personal learning environment. Therefore, development work is required to create new components for toolkits, and new services to support them to ensure that the Personal Learning Environment may become a practical reality.

A further significant outcome arising from dissemination events is the fact that a single description of the PLE (ie. A definition) is difficult. Whilst it is possible to describe the constituent elements of the technology (an embodiment of the principles of Web2.0 and service oriented architecture), as to what this means, there is still considerable disagreement. And inevitably, we are forced to reflect on the fact that to some extent, this is inevitable, since it is in the very nature of personal learning.

Implications

Technical Implications

There are two key questions with regard to the future development of technologies for the personal learning environment.

1. What technological platforms are appropriate for the future development of toolkits?
2. What additional services are required for the completion of the Personal Learning Environment?

With regard to 1, current rapid development in the Web2.0 space is introducing new technological opportunities for the development of toolkits. Of significance here is the degree of interoperability between different forms of toolkit. We argue within the report that the nature of a specific toolkit may be less important than the extent to

which it interoperates with other toolkits. In short, users should have a choice as the tools (or instruments) which they use.

With regard to 2 some of the services identified within the reference model do not yet exist. The role of these services (Workflow, Activity Management, etc) is to complete the adherence to the pattern map which we identified, and meet the challenges of the effective coordination and monitoring of learner engagement.

Recommendations

The recommendations for further developments and investigation cover a number of different areas. They are:

1. Development of Toolkits.
2. Development of Services
3. Investigation of Pedagogic Issues
4. Exploring links with other e-learning domains
5. Investigation of Organisational Issues

With regard to (1), there is an expanding array of possibilities for the construction of toolkits. These range from widget technologies (Yahoo Widgets, Apple Dashboard) to web browsers (Mozilla Firefox/Flock), to web-based technologies (portals, NetVibes), to fully-featured rich client development environments (Eclipse, Java, Microsoft Visual Studio). To some extent the issues pertaining to the construction of toolkits are of secondary importance to the construction of effective services and the establishment of inter-operability, however the PLE identifies the importance of the 'instrument' (and in particular the importance of users being able to have choice over instruments) in contributing to an effective user-experience, so further work in this domain is useful.

In the intervening period of the project, environments like Flock and NetVibes present major development opportunities which should be considered alongside the possibility of extending the development work in Eclipse within this project.

However, as we have made clear in the service specifications of the report, the PLE is not yet complete. In line with the development recommendations outlined in (2) Activity Management, Workflow, and various small-scale services are required to ensure that the pattern map established as a blueprint for the PLE can be fully realized. These additional services will equip the PLE with monitoring and coordinating facilities which will enable it to provide many of the coordinating functions of existing institution-based VLEs, and the monitoring power of existing e-portfolio implementations.

The technical developments outlined above carry with them a potential organisational impact. This organizational impact reflects the fact that the PLE presents not just a way to coordinate technology for learning, but rather a way to coordinate technology for life. In this sense it broadens the scope of the range of activities that can be performed by the learner, and from a pedagogical viewpoint (3) it also broadens the scope of the activities that may be coordinated by a teacher in a teaching and learning situation. The pedagogical possibilities that are unlocked by the PLE therefore reflect a new organizational landscape, and this landscape is almost completely uncharted. Therefore, work is required to start pushing at the boundaries of new organizational possibilities within the personal learning environment, to

identify new sorts of teacher interventions which take account of an expanded realm of possible teaching actions.

Of importance when considering this new organizational landscape are the links with other strands of e-learning discourse which have themselves been aspiring to address some of the fundamental problems which face learners as they attempt to integrate their learning over the course of their lives and within the context of daily existence(4). The e-portfolio agenda, in particular, has sought to address the issues of both life-long and life-wide learning. The PLE has an important contribution to this discussion – not least in a reformulation of the problem of interoperability (the PLE envisages learners owning their data independently from institutions, therefore interoperability issues are overcome), and of the monitoring of and effective intervention in learner engagements.

In addition to portfolio, further work needs to be done in exploring the relationship between learner-centred technology coordination and access to repositories and copyrighted material – challenges which initiatives for single sign-on technologies have a strong bearing. The emphasis on workflow and activity management within the PLE raises the need for studies of effective activity management practices, and possibly a deeper understanding of the nature of the relationship between the design and implementation of learning activities and the characterization of personal learning (and the personal commitment to learning) within a PLE.

Finally, work in the area of the management of personal identity has a strong bearing on the PLE conception. The management of personal identity as learners straddle diverse communities of practice is tied with the maintenance of different personas within those communities, and this too links back to the discourse on life-long and life-wide learning.

With regard to (5), the theoretical presentation of the PLE envisages a powerful intervention within a social mechanism which, we argue, is straining to cope with current organizational strategies. The PLE addresses these organizational issues, resituating the business of education with technologically-empowered learners and their own personal commitment to self-maintenance, learning and living. The extent of the transformative effects of the PLE could have far-reaching consequences for the organization and provision of educational institutions. These issues range from the day-to-day practical realities of the efficacy of providing centralised computing facilities (and whether it would be more effective for institutions to divest control of technology) to deeper and more profound questions about the role of the institution in supporting the educational development of learners.

However, we argue that issues 3-5 also require a transformed outlook in terms of how future research is conducted. The issues involved implicate not just technological matters, but also sociological and philosophical ones. And yet, in common with social science at large, effective methodological approaches for bringing these diverse perspectives together are in short-supply. Here the PLE project itself may provide a useful model for the conduct of future investigation. For whatever research outcomes may arise in future, it is likely, considering the personal nature of the domain, to be typified by diversity of opinion (and even contradictory opinion). This in itself raises important methodological and philosophical challenges. Can we coordinate effective action within the PLE domain in an environment of diverse opinion? In answer to this, we would argue that we have achieved something of the sort in this project, and that a coordination based on ethnographic reportage and effective modeling may be a powerful predictor for future directions in technology and an effective guide for future interventions.