D1.1 The STELLAR vision and strategy statement

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STELLAR

SEVENTH FRAMEWORK PROGRAMME

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The STELLAR Vision and Strategy Statement

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Executive summary

This First TEL Grand Challenge Vision and Strategy Report aims to:

- provide a unifying framework for members of STELLAR (including doctoral candidates) to develop their own research agenda
- engage the STELLAR community in scientific debate and discussion with the long term aim of developing awareness of and respect for different theoretical and methodological perspectives
- build knowledge related to the STELLAR grand challenges through the construction of a wiki that is iteratively co-edited throughout the life of the STELLAR network
- develop understandings of the way in which web 2.0 technologies can be used to construct knowledge within a research community (science 2.0)
- develop strategies for ways in which the STELLAR instruments can feed into the ongoing development of the wiki and how the they can be used to address the challenges highlighted in this report.

The report uses as a starting point the STELLAR Description of Work (DoW), which identified three major research themes, and draws on a number of other sources to develop and problematise issues arising within these themes. A key priority was to represent the perspectives of all interest groups within STELLAR and hence all members were invited to make contributions in face to face discussions and on a wiki set up for this purpose. The report can therefore be seen as adopting a 'bottom-up' approach which draws on the 'wisdom of the crowds'. Other sources included reports of the two previous Networks of Excellence, Pro-learn and Kaleidoscope; deliverable 7.1 (State of the Art in TEL report); reports and research papers in the public domain.

STELLAR has identified that it is important to develop understandings of the ways in which Web 2.0 technologies can be used to construct knowledge within a research community, and this report includes reflections on the use of the wiki as an instrument for co-construction of knowledge. The wiki will continue throughout the life of STELLAR and it is intended that it will grow and develop in order to inform further Vision and Strategy documents (D1.4 and D1.8). It can be found here:

http://www.stellarnet.eu/d/1/1/Home

The report begins with an introduction which sets the scene for the report. It suggests that technology has the potential to enhance learning and outlines a number of ways in which it can do so. It goes on to suggest that STELLAR recognises that research into the intersection between technology and learning ('Technology Enhanced Learning') is underpinned by a diversity of perspectives; in other words the research community can be seen as fragmented. It provides evidence of this fragmentation in terms of the research foci of different 'silos' within the TEL research community, taken from D7.1.

The second section of the report focuses on the three research sub-themes in the DoW and suggests emerging research questions.

> *Connecting learners.* This section is concerned with the potential of ICT to connect people with others who may be in some way relevant to their learning. It includes using ICT for knowledge building and sharing, communication and collaboration. The focus in the first part of this section is the use of Web 2.0 tools both within educational institutions and in the world of work. An important part of the discussion addresses the concerns arising from the 'democratisation' of knowledge which is considered to be a key value underpinning Web 2.0. The second part of this section suggests a range of enabling success factors for learner networks, which include factors related to the tasks being carried out using the network and the organisation of the network. The questions emerging from this section focus on new ways of understanding knowledge and the building of knowledge and ways in which to design and organise the use of technologies that make new ways of communicating possible.

Orchestrating learning. TEL learning situations can be very complex and it is important to understand how they are organised and how they work. This section uses the metaphor of orchestration to conceptualise the role of the teacher or more knowledgeable other in organising learning situations and making them productive. The roles of the teacher and assessment are considered in detail. The section also considers learning outside of formal educational institutions and practices, such as learning though gaming. Questions raised in this section concern ways in which to support teachers and more knowledgeable others in orchestrating TEL and ways in which the use of digital technologies challenge understanding of, and current practices in, orchestrating learning.

Contextualising virtual learning environments and instrumentalising learning contexts. This section discusses the importance of recgonising the role played by context in TEL, and suggests that technologies for learning should be designed to take into account the ways in which the settings where they will be used are mediated by the cultural context. It discusses how digital technologies, and mobile technologies in particular, can provide learners with novel experiences by exposing them to a wider range of contexts than was previously possible and by individualising the complex interplay of the technologies they use. It also addresses the issue of representing knowledge in an interoperable manner among various TEL systems. The questions in this section focus on understanding how novel experiences affect teaching and learning and the ways in which technology should develop in order to support novel experiences.

The report goes on to suggest strategies for using and developing the Grand Challenge Vision and Strategy by using the STELLAR instruments. Examples include

- using podcasts within the meeting of minds and to engage the stakeholder community, and to link these to the Grand Challenges wiki
- finding mechanisms for people involved in theme teams, incubators and the stakeholder community to continue to develop the Grand Challenge wiki
- using the Alpine Rendez Vous as a forum for further discussion of this document and to find mechanisms for the discussion to feed into the Grand Challenge wiki
- making the Grand Challenge wiki a central part of the Doctoral Community of Practice and requiring all doctoral academy events to contribute to the wiki
- working together with Work Package 6 to develop understandings about the social issues related to using Web 2.0 tools to construct knowledge and making explicit links with the Open Archive
- using this report and the wiki to inform choices and decisions within STELLAR such as focus themes for theme teams, doctoral academy events, and the mobility programme .

Finally the report **c**onsiders the ongoing challenges. The important point made in this section is that 'aggregating' the wisdom of the crowds is complex and difficult to understand; it suggests that searching for 'the' truth is a misguided notion and that (honest, not artificial) aggregation should be seen as the intertwining of multiple voices. It suggests that the Grand Challenge is not to reveal a specific research agenda, but to recognise the value of all the voices in STELLAR and to acknowledge that they all contribute to the 'truth'. Part of this Challenge is to develop a culture in which researchers work together within clearly understood theoretical and philosophical perspectives (which do not have to be agreed, but they do have to be explicit as far as possible).

In structuring this report around the three sub-themes of the STELLAR Grand Challenge it is inevitable that there are some important research areas that have been overlooked. In particular the issue of the digital divide is not currently foregrounded within the work of STELLAR. The report concludes by suggesting that this could be an important aspect of the work of STELLAR, that is

understanding how issues of the ‘digital divide’ permeate all aspects of the STELLAR Grand Challenge.

1 Introduction and background

> "In a changing world it is organisations' and individuals' capability to learn, rather than simply their access to information, that determines socio-economic development" (Kaleidoscope Report (Laurillard et al., 2007, p 3)
>
> "Since learning is social, personal, distributed, flexible, dynamic and complex in nature, a fundamental shift is needed toward a more social, personalized, open, dynamic, emergent and "knowledge-pulling" model for learning, as opposed to the one-size-fits-all, centralized, static, top-down, and "knowledge-pushing" models of traditional learning solutions". (Pro-Learn Roadmap (Kamtsiou et al., 2008), p 14)

The overall aim of STELLAR is to develop research concerning advances in Technology Enhanced Learning (TEL). STELLAR recognises that there are a diversity of perspectives related to technology enhanced learning; it is a multidisciplinary consortium that brings together researchers from psychology, education, cognitive science, computer science, organisational and management science.

This report builds on the collective understandings and diverse perspectives related to Technology Enhanced Learning of the STELLAR community. The approach taken draws on the idea of 'the wisdom of the crowds' (Surowiecki, 2004) which suggests that, under appropriate conditions, large numbers of people are able to make better judgements than particular individuals. The approach is predicated on the view that there is a considerable amount of expertise within the STELLAR network and that it is important to aggregate this expertise. Key instruments used to collect the knowledge and concerns of the community were face-to-face meetings and a wiki. Notes from the face-to-face meetings were posted on the wiki which was then further developed over a period of six weeks. Section 2 of this report is an edited version of what was written in the wiki [1].

The aims of this report are to:

- provide a unifying framework for members of STELLAR (including doctoral candidates) to develop their own research agenda
- engage the STELLAR community in scientific debate and discussion with the long term aim of developing awareness of and respect for different theoretical and methodological perspectives
- build knowledge related to the STELLAR grand challenges through the construction of a wiki that is iteratively co-edited throughout the life of the STELLAR network
- develop understandings of the way in which web 2.0 technologies can be used to construct knowledge within a research community (science 2.0)
- develop strategies for ways in which the STELLAR instruments can feed into the ongoing development of the wiki and how the they can be used to address the challenges highlighted in this report.

The development of digital technologies, their interfaces and association with communication technology, has opened up the possibility of accessing a large diversity of learning tools and a wide range of resources. Digital technology has the potential to enhance learning in a number of ways, some of which are suggested here. It can be a *communication too*l, which provides the means for people who are not co-located to collaborate (e.g. using a wiki, instant messenger, document sharing and track changes) and which provides teachers or more knowledgeable others with the

[1] http://www.stellarnet.eu/d/1/1/Home

possibility of communicating with learners when they are not face to face (e.g. via email and text messaging). Some technologies provides a *searchable repository* of information (on the Internet, on Virtual Learning Environments etc) which suggests that we should take seriously the need for information literacy and issues about quality of information and provenance. Digital technology allows learners to *try things out easily*, for example modelling applications, asking 'what if questions', using different designs or layouts and being able to change them easily. Some technologies can be used for *working things out* (such as calculators, graphing software, statistical number crunching). Some technologies can be used to *create new things*, such as documents, graphic designs and architectural drawings, sometimes combining a range of media such as text, graphics and sounds. Technology can also provide tools for *exploring* the world (and virtual worlds) to understand its function, structure, history, science, nature, ecology, and possible futures.

> Where complex simulations and experiments were once the property only of those with significant training and access to expensive machinery, now it is possible for anyone to input ideas, sketches, draft notes and, working with the computer, explore the implications of these ideas as simulations. Trial and error, rapid experimentation and evolution of ideas become possible. The challenge for education is to understand how best to harness this increased capacity, how to share ideas and information generated, how to engage with young people's capacity potentially to act as experimenters, designers and creators. (Daanen & Facer, 2007)

As the Kaleidoscope Scientific Vision (Laurillard et al., 2007) pointed out, it is clearly important to understand the influence of digital technologies on learning and to design more efficient and more relevant environments to support such learning. It is also important to work out how to use technology to best support visions for better ways of learning, such as those put forward in the Pro-Learn Roadmap (Kamtsiou et al., 2008). These include having access to learning resources at any time and any place and by 'promoting motivation, performance, collaboration, innovation and commitment to lifelong learning.' (ibid. p. 7).

STELLAR's work began with understanding the current landscape of research in TEL. The State of the Art Report (D7.1)[2] set out some initial findings with respect to trends in TEL research. An analysis of the titles of conference papers at the Ed-Media conference in the years 2000 and 2008 showed that the dictionary size has grown, and this suggests an opening up of the field. New terms used in 2008 (and not in 2000) included blended, ICT, mobile, portfolio, space, peer and podcast. Some of these terms could represent new ways of thinking about existing ideas (for example ICT is now commonly used instead of computer) but many of these words suggest new research interests of the community. Other terms have increased in frequency, and these include digital, teacher, practice, social, student, game, science, assess, effect, implement, innovative. Again, some of these terms may have gained in popularity as words, whereas others may indicate growing areas of interest for research. A similar analysis of titles of a sample of publications in the DBLP computer science bibliographic database[3] suggests the following trends:

> 'Increased attention for situational, game-based learning, as well as for ubiquitous learning.
>
> Embracing of Web 2.0 techniques (mining, automatic) and open software.
>
> Some technological changes: the Web has become mature and widely accepted, no one uses the words 'agents' anymore. (p. 39)

The report suggested that the DBLP database can be seen as representative of one 'silo' within TEL research (computer science), whereas the TELearn database[4] is more representative of the pedagogy-oriented 'silo' of the field. Terms from titles (and abstracts in the case of TElearn) in these

[2] This can be downloaded from http://www.stellarnet.eu/d/7/1/Home

[3] Available from http://www.informatik.uni-trier.de/~ley/db/

[4] http://telearn.noe-kaleidoscope.org/

databases were compared using a comparison word cloud technique. The report concludes that 'both sets cover different topics within TEL' (p. 43) and points out that

> 'There are also some technical terms that appear only in DBLP: teaching computer, data structures, operating systems, online discussion, introductory programming, support system, learner models, novice programmers, peer assessment, personalized e-learning, programming courses, undergraduate research, augmented reality, automatic generation, science courses, search engine, cs education ….. All in all the analysis shows that both data sets cover different topics within TEL.' (p.43).

An analysis of two future looking reports, representing the computer science and the pedagogy-oriented 'silos' also found differences in research interests and priorities of the different communities. The State of the Art report suggests that the psychological/education community (represented by the Horizon Report (Johnson et al., 2009)) seems to be interested in leadership and direction, measurement and assessment whereas the technical community (represented by the Pro-Learn Roadmap (Kamtsiou et al., 2008)) seems to be interested in access, performance and outreach.

The analyses within the State of the Art report suggest fragmentation within the TEL community. The Kaleidoscope and Pro-Learn visions put forward in the Vision Statement and Roadmap confirm this fragmentation. STELLAR research aims to reduce this fragmentation.

In addition to this introduction, the report has three sections. Section 2 represents the understandings and concerns of the STELLAR community with respect to technology enhanced learning, Section 3 outlines the methods adopted, reflects on the use of the wiki and suggests some lessons learnt and ways forward. Section 4 proposes possible strategies for the use of STELLAR instruments as related ot the Grand Challenges and Section 5 is a concluding discussion.

2 The three themes that guide the Grand Challenge

The scientific work of STELLAR is organised around three themes that guide the Grand Challenge: 1) Connecting learners 2) Orchestrating learning 3) Contextualizing virtual learning environments and instrumentalising learning contexts. These themes are intended to be a starting point for providing a framework to identify and formalise the TEL Grand Challenge in order to advance the future of technology enhanced learning. The three themes are continuously being developed within the STELLAR Grand Challenge wiki. [5]

2.1 Connecting learners

> With the increasing possibilities of using computers as communication tools, they play an important role in rethinking and advancing our current perspectives on learning and instruction, knowledge management and creation, etc. In society, schools and organizations people are more and more sharing, discussing, and negotiating knowledge through computer networks, therefore stressing the social nature of learning. (De Laat & Simons, 2002) p.1

People are at the heart of learning and knowledge construction and a crucially important role for information and communications technologies is to connect learners with other learners and teachers, trainers, experts in a particular field or more knowledgeable others. The Internet (Web) is increasingly being used to connect learners and new tools are continually being developed to enhance processes of connecting and communicating. On the Web, we can see that self-directed, self-managed and self-maintained communities create successful new forms of collaboration (Wikipedia provides a well-known example). Within successful communities, inherent incentive mechanisms to motivate and encourage participation exist. Wide-ranging tools are used by these communities for knowledge sharing and building, communication, collaboration and networking. Knowledge sharing and building is facilitated by open and closed forums, Wiki pages and personal or shared blogs. Multimedia material is shared using popular tools such as FlickR and YouTube.

Communication takes place using forums, annotation, tagging, chat rooms, instant messaging and video conferences. Collaboration is facilitated by shared media repositories, version management systems and collaborative text editing systems such as Google Docs. Networking portals, such as Facebook and LinkedIn, allow professionals to find, contact and keep in touch with like-minded people.

These technologies are beginning to replace centralized, static technology-push models with new interactive models that reflect the continuous, social nature of learning and this shifts the focus from knowing what to a focus on knowing how and knowing who.

Research questions include:

- What design principles should underpin tools and mechanisms to encourage online participation in communities? Why?
- How can the use of digital technologies take advantage of what we know about the social nature of learning?

2.1.1 Networked learning

> The term 'networked learning' has been introduced to describe the forms of learning taking place in groups or in communities to promote connections between learners, tutors and educators, and between a learning community and its learning resources. (Laurillard et al., 2007) p.5

[5] http://www.stellarnet.eu/d/1/1/Home

A ‘network for learning’ can be considered to be a group of people who are connected in some way with the overall purpose of learning. Such a network provides support for people to build new contacts to scaffold each other to successfully acquire new knowledge and competence. In this process people may exchange information, tools and artefacts. Depending on the context, the network can be either formed through formal injection, or may spontaneously form thanks to a natural aggregation of people around a common interest/topic.

Although many of the networking activities may take place in face to face situations, increasingly they are supported by online activity, which often allows members of the network to share resources and information quickly and easily.

Within modern European society, very many people have online access at work/school/college as well as at home. This means that people are able to access resources and information within more formal learning situations (such as at school) and in informal learning situation (such as at home). Therefore it can be argued that the boundaries between formal and informal learning are becoming blurred. In addition, it can be argued that digital technologies sometimes provide artefacts and infrastructures to enhance the intertwining of cognition with social and affective dimensions and this means that people may engage in ‘learning’ more willingly.

It is sometimes argued that Web 2.0 technology can be seen as a particularly important development in this respect because it is underpinned by a philosophy that values the collective intelligence of the community (see, for example, O'Reilly, 2005). Web 2.0 tools are changing the way we engage with and participate in the web: from a mainly read-only approach we are moving to a wide set of “spaces” where users are able to express themselves by writing, adding comments to others’ contributions, posting many kinds of produced material. Often, the process of knowledge production is made public; the collaboration space is a public space and open for potential contributions from others (for example in a wiki). A key value of Web 2.0 can therefore be seen as the democratisation of information and knowledge:

> ‘… Web 2.0 has been ushered in by what might be a thought of as rhetoric of 'democratisation'. This is defined by stories and images of 'the people' reclaiming the Internet and taking control of its content; a kind of 'people's internet' or less positively, the emergence of the cult of the amateur (Keen, 2007). This, we are led to believe, has led to a new collaborative, participatory or open culture, where anyone can get involved, and everyone has the potential to be seen or heard.’ (Beer & Burrows, 2007)

This democratisation of knowledge means that the producer and consumer boundary is becoming blurred, and can also lead to concerns over the provenance and trustworthiness of information posted on the Web, as there is often no editorial control over what is posted. Related to this ‘there are profound intellectual property debates ahead as individuals, the public realm and corporations clash over ownership of the huge amounts of data that Web 2.0 is generating and the new ways of aggregating and processing it.’ (Andersen, 2007)

A second concern is about privacy and security of information. As users post photographs and details of their lives (for example on Facebook) they build up a history of their everyday lives, which can include their preferences and choices. This information is available and can be accessed in various ways; for example in Facebook a user can click on a preference (favourite book or film) and see who else on Facebook chose that film.

Emerging new practices have been registered in many fields related to Web 2.0 (e.g. new business models, open source movements) which suggests that it is possible that new practices might also emerge within educational institutions. The ways in which Web 2.0 tools can be used in education are still being explored. For example, the behaviours and interactions described above do not emerge spontaneously, which is why for learning purposes collaborative strategies are often implemented by, for example, assigning a group of students with the task of collaboratively discovering the solution to a given problem (collaborative problem solving) or developing a written

text (co-writing) based on a given argument. (Trentin, 2004). We also need to consider the different forms of knowledge which might be constructed by students. For example learning about decimal numbers may not be the same as learning the functions of a new camera.

Personal learning environments (PLEs) allow learners to manage and control their own learning. They could provide support for learners to set their own goals, manage the content and process of their learning and communicate with others as they learn. The software used for PLEs varies from desktop applications to a range of web-based services. One perceived strength of PLEs is that they are able to integrate formal and informal learning episodes into a single experience. They often use Web 2.0 technologies such as social networks, which cross institutional boundaries. (PLE's should not be confused with Learning Management Systems (LMS) or Virtual Learning Environments (VLEs) which operate within single institutions).

In the world of work there has been a change in emphasis from mass production to a focus on the needs of the customer. This has been accompanied by changing demands on employees with 'a shift in expectations regarding employees' actions, from the ability to execute specific commands towards a greater ability to conduct personal judgements and take personal initiatives'(Laurillard et al., 2007, p 3). Such a focus on the individual's potential to act and make decisions in the workplace has been accompanied by a move away from central control to allow for the 'creative chaos, fluent behaviour and redundancy needed for collaboration, creativity and innovation'. (Kamtsiou et al., 2008, p 13). In this respect a 'knowledge worker is defined as someone who doesn't just consume knowledge but who is able to create it and who reflects critically …'. (ibid, p 7)

There is increasing mobility in the workplace and fewer workplaces have physical centres. Flexibility will require new, changing skills: social networking, reconstructing views of institutions and companies, etc. In this respect creative industries have already reconfigured and tend to be characterised by flat hierarchies with the distinction between workforce and managers being no longer valid.

This movement makes informal learning especially important. More 'lifelong learning' and more informal professional development seems to be taking place within the workplace. Diversity and decentralisation pose serious challenges for corporations, with risk and responsibility often shifting to an individual level.

Research questions include:

- What is the provenance of information / knowledge? Where did it come from, and what is its quality? What and whom can we trust?.
- How do teachers and students respond to working in public and making their work in progress visible and/or accessible for others (e.g. on a wiki)?
- What new practices, influenced or enabled by Web 2.0 technologies, will begin to emerge in educational institutions and how will they be embedded in formal educational situations?
- What are the implications of 'self-directed and collaborative learning' in terms of physical and virtual spaces?
- What role do face-to-face encounters have in workplace learning and in learning in educational institutions? How important is this physical contact?

2.1.2 Key enabling success factors for learner networks

> 'The potential for learner networks seems considerable, given the range of challenges to which organisations must respond in new ways. But it is also clear that there is still a considerable gap between rhetoric - what could and should be done to build such networks - and the reality of their implementation. Much work needs to be done on understanding the challenges involved in successful operation of learner networks, and the tools with which to facilitate their development and survival' (Bessant & Tsekouras, 2001).

The sections above have suggested that TEL-based learner networks may contribute in positive ways to the processes of learning. However, it seems that very often it is difficult to build up and maintain such networks. The TEL research community is continuously addressing why this may be so. The

question for solving the cold-start and maintenance problem for such networks can be rephrased into “how can we get agents in, and how can we get them to stay?”.

Possible enabling factors, discussed below, of learner networks relate to the way a network is used by the learners and to the way a network is organised.

It is widely recognised that a ‘common’ task can help to build relationships among learners see for example (Engestrøm et al., 1999, Trentin, 2004, Wenger et al., 2002). In order to carry out a shared task, members of the network will negotiate, use and produce shared artefacts, tools and languages.

In virtual contexts the issue of identity is one of the most discussed topics (sense of identity, construction of one’s own identity, exploring who you are and who you want to be, possibility to take risks, sense of belonging, shaping personality, individual vs. group identity, group cohesion, etc.). It seems to be important to establish a safe environment in which individuals are able to construct their own identities.

Collective activity allows distribution of work, exchange of support, shared responsibility but it may also weigh more heavily on some group members than others. Methods and rules must be designed to ensure productive collaborative learning activities, possibly inspired by those proposed for co-writing environments. (See Noël & Robert (2004) for a detailed discussion of collaborative writing and tools used.)

Organising the work of a network is based on rules and procedures, which may be suggested by a network manager or – by contrast - be left up to the network itself. The network may thus be quite autonomous or be strongly guided (this relates to issues of responsibility vs. control). Monitoring the learning process, or the fulfilment of shared activities, can provide insights about how the network is growing, changing, moving.

If, on the one hand, technology allows the network to be time-and space-independent, on the other hand, synergies seem to benefit from synchronisation (people working at the same time on the same issue).

Tools used within a network can embed principles of teaching and learning, and they frame communication and the shared repertoire accordingly. These constraints should be taken into account when learners and teachers are making choices about which tools to use within a network.

Research questions include:

- What sort of rules and procedures support learner networks, both in terms of keeping the network lively and active and in terms of learning? How do Web 2.0 tools affect the organisation process?
- How can we best support shifts between a central position and a distributed position? Can a formal learning situation (a course) be shifted to an informal one (the formal setting induces weak ties which can afterwards be turned by people into strong reliable networks, with reciprocity, responsibility, etc.)?
- In which ways should we balance synchronisation and asynchronisation in a learner network? How could such a balance be supported by technology?
- What network activity should we monitor? How do web.2.0 tools affect monitoring? How should monitoring data be shared with the learners and what would/could this achieve?
- What design criteria should be used for the tools aimed at supporting a network? What about the issue of “tool transparency” and the possibility offered by technology to reflect/imitate the real world? What kind of impact does this have on a leaner network?

2.2 Orchestrating learning

> In 1990 Salomon suggested that for the computer to be an effective classroom tool, "most everything in the classroom needs to change in a way that makes curriculum, learning activities, teacher's behavior, social interactions, learning goals, and evaluation interwoven into a whole newly orchestrated learning environment" (Hopson et al., 2001, p. 51).

TEL situations are frequently characterised by a multiplicity of resources, a multiplicity of devices, a multiplicity of agents (co-learners, teachers or trainers, artificial or human agents). TEL learning situations can be very complex and it is important to understand how they are organised and how they work. Dillenbourg and Jermann (2009) discuss the potential of the word 'orchestration' as a metaphor for understanding and informing the design of technology enhanced learning situations, and at the same time introduce the idea of the classroom as an eco-system. Some new keywords in TEL research, such as learning scenario and classroom orchestration bear witness this priority. While scenarios describe the organisation of learning from a time, event and activity perspective, orchestration takes up the challenge of the actual implementation of all the interactions needed for a successful scenario (Niramitranon et al., 2006). It is in this sense that Fischer and Dillenbourg (2006) spoke of orchestration as the process of productively coordinating supportive interventions across multiple learning activities occurring at multiple social levels. It is also important to consider the ways in which the orchestration of a learning intervention has to adapt to the local situation, that is 'adaptive orchestration' that takes into account the needs and flow of the learning moment.

Understanding how learning is orchestrated can be modelled using tools designed for this purpose. Today, there are a wide variety of models and application contexts that allow meaningful comparisons. We can distinguish approaches that focus on learning objects (such as Shareable Content Object Reference Model (SCORM)[6]), approaches that focus on prescribed tasks (IMS learning design[7]), approaches that focus on interactions (Learning Design Language (LDL)[8]), approaches that focus on objects produced or "emerging learning objects" (Science Created by You (SCY) FP7 project[9]) or approaches led by the intentions (Intentions, Strategies, interactional Situations (ISiS)[10]. Each of these models targets specific audiences or specific economic models (professional or academic training, primary, secondary or higher education, distance e-learning or blended), specific areas of knowledge (scientific knowledge, skills, communication skills etc.) or specific teaching approaches (collaborative approach, discovery learning, etc.).

The practical impact of the richer and more complex world of learning resources is the requirement for more and new collaborative competencies for using, generating and exchanging knowledge in a peer-to-peer manner and for participating in communities of learning. This presents a challenge in terms of finding methods and principles, as well as concepts and tools, to engineer learning situations and/or learning environments. One response to this challenge is the implementation of collaboration scripts, which do not only structure specific activities and interaction patterns but also support orchestration of individual and collaborative learning activities within the classroom over longer time segments (Dillenbourg & Jermann, Submitted, Dillenbourg & Tchounikine, 2007, Kobbe et al., 2007, Masterman & Lee, 2005).

Issues of orchestration and coordination are relevant whether considering learning within educational institutions or learning within the workplace. In the workplace it is often important for people to coordinate and orchestrate learning activities between each other. In this respect there is

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[6] http://www.adlnet.org/Technologies/scorm/default.aspx

[7] http://www.imsglobal.org/learningdesign/

[8] Described in Ferraris, C., Martel, C. & Vignollet, L. (2007) LDL for collaborative activities, in: L. Botturi & T. Stubbs (Eds) *Handbook of visual languages for instructional design: Theories and practices* (Hershey, PA:, Idea Group).

[9] http://www.intermedia.uio.no/display/Im2/SCY

[10] Pernin, J.-P., Emin, V. & Guéraud, V. (2008) ISiS: An Intention-Oriented Model to Help Teachers in Learning Scenarios Design*Times of Convergence. Technologies Across Learning Contexts*

an interplay between the different roles a knowledge worker might play: the role of the worker (getting the task done), the role of the learner (improving competencies in order to be able to approach new tasks or to improve the quality of known tasks) , and the role of the expert or more knowledgeable other (helping other people getting their tasks done). Each of these roles places different demands on the orchestration process which relates to the third theme of contextualising learning (Section 2.3). It has been shown that switches between these roles takes place on the activity level (micro-level) (Eraut & Hirsh, 2007) and are strongly related to the task at hand. In addition, in the workplace learning proceeds along different learning trajectories (ibid), for example the social trajectory, the topic trajectory, and the cultural trajectory, which do not exist in isolation from each other but stay in constant interaction.

The State of the Art report pointed out that gaming is gaining increasing research interest. There is evidence in the research literature that games have the potential to contribute to learning (see for example Aldrich, 2005, Gee, 2003, Kirriemuir & McFarlane, 2004), and we suggest that the point made below by Richard Van Eck below is important:

> One could argue, then, that we have largely overcome the stigma that games are "play" and thus the opposite of "work." A majority of people believe that games are engaging, that they can be effective, and that they have a place in learning. So, now that we have everyone's attention, what are we [Digital Game Based Learning] DGBL proponents going to say? I believe that we need to change our message. If we continue to preach only that games can be effective, we run the risk of creating the impression that *all* games are good for *all* learners and for *all* learning outcomes, which is categorically *not* the case. What is needed now is (1) research explaining *why* DGBL is engaging and effective, and (2) practical guidance for *how* (when, with whom, and under what conditions) games can be integrated into the learning process to maximize their learning potential. We are ill-prepared to provide the needed guidance because so much of the past DGBL research, though good, has focused on efficacy (the message that games can be effective) rather than on explanation (why and how they are effective) and prescription (how to actually implement DGBL). (Van Eck, 2006 p 2)

As Van Eck points out, we need to find ways to understand what it is that is effective about game based learning and to use this knowledge to inform the design of games designed for learning.

Related to this, it may be that new models of orchestration, tailored to new learning experiences like serious gaming, are required. The use of games significantly complicates the task of orchestration. It is not just about making the learner play, but also verifying that an activity promoting the immersion is compatible with the learning objectives, with the socio-professional constraints and with the individual values of learners. The specificities of games (players, roles, missions, rules, etc.) and known mechanism in games (mimicry, agon, alea, illynx) require us to define new ways of orchestration.

Research questions include:

- In which ways can TEL learning situations be seen to be more complex than learning situations in which digital technology is not used? Is the job of orchestration necessarily more complex in these situations? Why?
- Are there key differences between orchestrating TEL learning situations in educational institutions and in the workplace? What sort of different things would teachers (or more knowledgeable others) have to take into account?
- What characteristics of gaming contribute to learning, and in which ways? How can we exploit knowledge of these characterisitics to inform the design of other learning activities?

2.2.1 The role of the teacher or more knowledgeable other

> "No educational reform can get off the ground without an adult actively and honestly participating — a teacher willing and prepared to give and share aid, to comfort and to scaffold. Learning in its full complexity involves the creation and negotiation of meaning in a larger culture, and the teacher is the vicar of the culture at large. You cannot teacher-proof a curriculum any more than you can parent-proof a family" (Bruner, 1997, p 84).

As a starting point, we consider what is meant by the term 'more knowledgeable other'. If we see knowledge as distributed and constantly changing, how do we understand what knowledge is? Is there a tension between 'wisdom of the crowds' and a teacher as facilitator/orchestrator? What does a more knowledgeable other offer? In what learning contexts is it important to consider the role of more knowledgeable others? Faced with the change in the status of written documents (now less sanctified), to the new means of communication and expression, there is increasing uncertainty about what counts as knowledge and whose voice can be trusted. (See Section 2.1). To this uncertainty TEL research must respond by addressing epistemological concerns in the new context of the digital world, or by being explicit about the (pragmatic) epistemological positions as a basis for its scientific programme.

Historically, modern society has devolved to the teacher the role of the 'more knowledgeable' with respect to the students he/she is responsible for teaching. However it is increasingly recognised that other students within a teacher/student community might also be 'more knowledgeable others'. Recognising this does not de-value the role of the teacher, which could involve inducting students into new language practices, taking a scaffolding role, and being the orchestrator of learning resources and activities.

Within educational institutions the teacher plays a major role and in particular with respect to the coordination (and aggregation) of knowledge, as recognised by all those who have researched the use of TEL in authentic classrooms (see for example Sutherland et al., 2008). Two extremes in the conceptualisation of the teacher can be shown by an interesting metaphor: Conductor of orchestra vs. instumentalist/performer. This metaphor would suggest that in addition to thinking about the teacher's role as changing from 'the sage on the stage' to the 'guide on the side', we should also be thinking in terms of a transition to the conductor's role. The conductor would have knowledge of how music is perceived but not specialist knowledge of how to play a particular instrument. The conductor has competence in assembling together what sounds good in terms of a collective performance. In this respect orchestration is more than guiding or facilitating, but should rather be seen as bringing together the parts to a make a 'new' whole.

However research has shown that teachers are often unsure of their new emerging roles once technology-enhanced learning has been introduced in the classroom (see for example Sutherland et al., 2008). When it comes to orchestrating student-centred forms of instruction (e.g. inquiry learning) a lack of flexible classroom scripts on the teachers' side has been shown by research. (For example, see Wheeler (2001)). This may be because the use of these ways of working may not sit comfortably with current classroom practices:

' … other contextual factors which can act as barriers to using ICT include classroom practices which clash with the culture of student exploration, collaboration, debate, and interactivity within which much technology-based activity is said to be situated (Hennessy et al., 2005) p. 9

To understand what happens in the TEL classroom, and the 'work' the teacher and students create together, it may be helpful to consider the concept of oeuvre that Bruner introduced, Based on the work of a cultural psychologist, Meyerson (Meyerson, 1948). As Bruner explained it, oeuvres can be grand, such as arts and sciences of a culture, as well as minor, such as a school team winning a soccer game. 'Oeuvres are often touchingly local, modest, yet equally identity-bestowing' (Bruner, 1997, p 22). Part of the orchestrating role is to promote and optimise the 'oeuvre'. In the classroom it is important to consider the importance of oeuvre, which could be a performance. However conceptualising classrooms assets as 'oeuvres' and developing more collaborative working practices may introduce some tensions when we consider that across Europe, everything is assessed individually (see next section).

With respect to the design of TEL there is a need for tools to assist teachers in the design of scenarios. Laurillard (2009) suggests one such tool (for Computer Supported Collaborative Learning (CSCL) contexts), which she terms a 'conversational framework'. Further, teachers need tools at run time (when students actually use the environment and learn), there is a need for tools to supervise students' activities, especially tools that allow keeping track of, or understanding, the actual activity of learners or groups of learners in comparison with the originally prescribed activity. A conductor may also want to be able to dynamically regulate the activities and modify the conditions of orchestration. In this way, the scenario may be adapted in run time. At evaluation time, tools are needed to assess students' learning.

The discussion above raises the question of how TEL environments can be orchestrated and integrated in regular classroom practices (across all sectors of formal and informal education) in a way most fruitful for learning. We suggest that to answer this question an integration of cognitive, socio-cognitive and sociocultural approaches, both with respect to theory and methodology is required. Crucially, as Laurillard (ibid) points out, 'To get the best from [new technologies] for education we need to start with the requirements of education, in terms of both learners' and teachers' needs' (p.1)

We consider the idea of reconceptualising the role of teacher to be very important. Teachers still retain a role for orchestrating (and conducting) but some thinking is needed about how the role could be devolved to the group level. Structures in educational institutions (including national and regional policies) constrain what is possible and there will inevitably be a need for new forms of assessment (see Section 2.2.2).

Research questions include:

- In TEL situations within educational institutions how can teachers harness the collective 'wisdom of students', whilst at the same time valuing their own role as 'knowledgeable other'?
- What sorts of professional development/change management programmes would support teachers and institutions to change in order to take full advantage of technology (e.g. centralised policy directives, more bottom-up approaches to change, learning networks for professional development)?
- How could the orchestration of technology-enhanced processes of learning and instruction on different social levels (individual, small group, classroom) be facilitated by different classroom scripts?
- How should the physical space in which classroom practice occurs be designed to encourage a successful orchestration of different TEL environments and approaches to learning?
- An implication of the wealth of information available on the Internet is that everyone - in addition to the knowledge gate keepers - needs to question the validity, relevance and provenance of information. In this respect how has the role of the more knowledgeable other changed?
- What is the role of parents or carers of very young children when digital technologies are used for learning in the home?

2.2.2 The role of assessment

> "Massively researched and comprehensively analysed, two results in this area seem incontestable: (a) educational systems are driven by assessment systems and (b) many current approaches to assessment seem at least as likely to inhibit as promote learning. Assessment and target setting are not going to go away. How best to use assessment to promote learning? The research and professional

community owes the political community more than criticism here". (Coffield, 2006, p 6).

Be it by the teacher, the trainer or the learner him or herself, there is a constant need for verifying and ensuring that the learning process evolves well and in a direction which corresponds to the intended learning outcomes. It may be the case that such outcomes do not have the same meaning for all the protagonists, and are ill defined, but they will always have a structural role in (intentional) learning situations. For these reasons assessing and tracking learning processes are crucially important. Orchestration must take this constraint into account, being able to make sense of what is happening in order to evolve in a way which effectively supports learning, and beyond that providing the means to certify the knowledge, skills or competences of individuals.

Assessment can be formative or summative, and can include self-assessment and assessment of learning outcomes. In this process, technology can help by providing information to both the teacher and the learner. Further, for both teachers and students, assessment is able to help identify 'gaps' in students' knowledge. For individual students, assessment provides a well-understood way of talking about their achievements, and it is often in referring to the results of assessment (e.g. a PhD degree) that students begin to build their reputation.

Assessment is also useful to those outside the particular teaching and learning situation in that it provides a means of 'filtering' for potential employees, and for acceptance on a higher degree course. For example, an employee may decide only to employ learners who graduated with an A-grade in mathematics, and a university may only allow students with first class degrees to enrol in a Master's course.

Technology, because of its capacity to record, represent, store and treat the trace of learning activities could provide efficient and reliable tools and means for teachers, trainers and learners to assess learning. Further new technologies may provide a broader basis for assessment than has previously been possible because a range of media could be used to provide evidence of learning. In this way, technology can be seen as 'liberating' assessment.

The idea of 'oeuvre', discussed in the previous section, could also be used as a learning asset that forms the basis of an assessment process, becoming part of a learning 'portfolio'. However there are some problems associated with using digital 'oeuvre'. Plagiarism has become a problem, largely because so much information is freely available on electronic media such as the Internet and CD-ROMs and because it is very easy for students (learners) to copy and paste information directly from these sources into their own documents. Trust is a key issue for new forms of technology-driven assessment. For example, the Open University in the UK requires students to appear in person at given physical locations to carry out examinations even though the courses are mostly 'delivered' online, and online assessment might seem to be an obvious choice. It may be necessary to find ways in which students can defend their work (oeuvre) in an oral examination as is currently the case in PhD examinations.

Observation and control of activities and situations can be seen to relate to formative assessment. Indicators that are relevant for the supervisor (tutor) and that allow multiple and complementary views of the learners provide useful tools for learners (and tutors) to reorganise objectives or tasks without compromising the consistency of the scenario.

Research questions include:

- How can we best articulate TEL approaches in the classroom with effective assessment processes?
- In which ways can we provide students with sufficient opportunities to defend their work in order to overcome issues of plagiarism?
- Developments in digital technology could be seen to favour 'centralised' and 'de-personalised' modes of assessment such as multiple choice tests. What are the implications for education?
- What are the relative advantages and disadvantages of technology assisted assessment?

- What do we know about mechanisms for dynamic re-orchestration of learning situations by the tutor and the learner, and how can we extend this work?
- What new forms of assessment are made available by digital technologies, for example learning traces?

2.2.3 Higher order skills and knowledge domains

> 'The skills of enquiry, analysis, synthesis, collaboration, knowledge negotiation, evaluation, communication, are the high-level cognitive skills that we all need as citizens and as a workforce' (Kaleidoscope Report (Laurillard et al., 2007) p 4)
>
> " [ ] develop specific competences related to thinking out of the box, creativity, asking the right questions, leadership" (Pro-learn Roadmap (Kamtsiou et al., 2008) p 13).

It is generally accepted that it is important for students to develop higher order skills, (Bloom & Engelhart, 1956) . Teaching higher order skills is one of the challenges the educational community has been facing for a long time and the orchestration of the best ways in which to do this is important if the educational community is to meet this challenge. The discussion below concerns these skills and issues related to teaching them.

Higher order skills and learning are meta-cognitive abilities related to making connections, transferring knowledge, transforming knowledge and reflecting on learning. They include skills of search, evaluation and retrieval, and it could be argued that the increased use of technology is provoking people to use such higher order skills (Wegerif, 2002). At the same time, it is possible that digital technologies can be used to develop these skills (Hopson et al., 2001) and TEL researchers are building tools that support these skills (for example, metAHEAD, see McLoughlin & Hollingworth, 2002)).

One reason why attempts to teach metacognitive skills has often been disappointing relates to the paradox of teaching, turning metacognitive skills into explicit objects of teaching and learning deprives them of their metacognitive nature[11]. Indeed in the process of 'teaching' they become 'pieces of knowledge' of the first order, and in this respect they become explicit. In this process new areas of implicitness are generated. But still the problem, the paradox, is there: the more you teach higher order skills and knowledge the more they are learned as first order skills and knowledge which themselves need their metacognitive environment (one may call that their control structure). Educators need to make progress on proposing solutions, but it cannot be by explicit teaching or training, rather by understanding which interactions, situations and practices favour the emergence of higher order skills without reifying them for educational purposes. It is interesting from this point of view to look back to the work on problem solving, metacognition and heuristics at the end of the 70s.

Moreover, certain higher order skills are domain specific, others are not. But the learning problem is the same. It might be easier to model and propose solutions in the case of domain specific higher order skills, for example although you can teach argumentation, the impact on the learning of mathematical proof is not straightforward.

Given the important role of assessment it is suggested that there is a need for higher order skills to be assessed, although as the discussions above suggest this is clearly a challenge.

The discussion above has been concerned with formal (classroom learning), but we recognise that there is a big difference between learning in formal and more informal settings. In informal learning situations, who decides what is core knowledge? We should also consider knowledge building in

[11] This ideas in this paragraph were generated by Nicolas Balacheff and draw on the work of Brousseau (1997)

informal/formal groups and understand how such processes work within 'Science 2.0'. It seems to be important to understand issues related to assessing higher order skills in informal learning.

Research questions include:

- Most educational institutions have fixed separate subject structures. Is it possible to learn higher order skills within these structures?
- Which higher order skills are particularly important within TEL?
- How can higher order skills be assessed in both formal and informal learning situations and what is the role of TEL in this respect?
- How can TEL contribute to the teaching and learning of higher order skills?

2.3 Contextualising virtual learning environments and instrumentalising learning contexts

> "Where in the past schools, universities and other institutions grew around the fixed resources of libraries and laboratories – if information can be accessed anywhere, if simulations and experiments can be run anywhere, if 'human' interactions can be achieved virtually in any location, where does learning need to take place?" (Daanen & Facer, 2007, p 16)

All activity is performed in context. Cole (1996) makes an important distinction between context as "that which surrounds us" and context as "that which weaves together". This mirrors the distinction made in the technical literature on pervasive computing between context as a 'shell' that surrounds the human user of technology and context as arising out of the constructive interaction between people and technology. The 'context as shell' model, exemplified by the Shannon-Weaver (1949) informational model of communication situates the learner within an environment from which the senses continually receive data that are interpreted as meaningful information which contribute to constructing understanding. Thus, a learner in a classroom may receive information from a teacher, a whiteboard and a text book, all of which must be assimilated and integrated to form the learner's composite understanding of the topic being studied.

But learning not only occurs in a context, it also creates context through continual interaction. The context can be temporarily solidified, by deploying or modifying objects to create a supportive workspace, or forming an ad hoc social network out of people with shared interests, or arriving at a shared understanding of a problem. But context is never static. The common ground of learning is continually shifting as we move from one location to another, gain new resources, or enter new conversations (Lonsdale et al., 2004, Sharples et al., 2005).

The learning context is the set of 'objects' in a broad sense that can be grasped by a learner in a learning experience. This set of objects includes physical objects, digital objects such as online resources and people in the environment of the learner. These objects can serve as clues for learning, either explicitly or incidentally. In short, the context is set up by a situation designed and implemented in a certain environment with certain learning objectives. It is never fixed, but evolves together with the learning process. It is in this 'context' that each learner will, in interaction with others and managing the resources and constraints to which he or she is confronted to, build the milieu from which the intended learning will emerge. In this respect a learning context is continually created by people in interaction with others, with physical and digital objects, with their surroundings and with everyday tools.

Complementarily, the interplay between formal and informal learning in formal and informal contexts has to be instrumentalised through the use of physical artefacts, mobile devices and the configuration of physical and virtual space, in order to create learning opportunities beyond traditional institutional boundaries.

Technologies for learning should be designed to take into account the ways in which the settings where they will be used are mediated by the cultural context. Traditional classroom learning is founded on an illusion of context stability, by setting up a fixed location with common resources, a single teacher, and an agreed curriculum, which allows a semblance of common ground. But if these

are removed, a fundamental challenge is how to form islands of temporarily stable context to enable meaning making from the flow of everyday activity.

Research questions include:

- Will there be a role for schools and colleges in the future? If students are able to access content and communicate with teachers any time and any place, what will the function of the school be?
- What do we know about contexts that seem to be effective for learning? How can this inform the way teachers set up TEL contexts?

2.3.1 Novel experiences mediated by new technologies

Since the end of the 19th century classrooms in Europe have more or less functioned as stable contexts for learning within formal educational institutions. With the Bologna accord[12], new forms of governance of training and educational practices within higher education are emerging. In particular, there are fewer hours of instruction available and approaches based on skills (competencies) are encouraged. At the same time, digital technologies can also provide new environments (e.g. 3D simulations, haptic simulations, physical models) for students and work-based learners to practise their skills before refining them in the real world. Furthermore technology enables students to be connected to worlds outside the classroom, even if the learning context is bounded by classroom walls.

In this respect the classroom as a context for learning is being challenged as the dominant site for learning. Increasingly, students find their own places to learn, not constrained by walls of the classroom. In this respect there is a tendency to think beyond the classroom as the main site for learning and to put forward more personalised alternatives in which the learner creates their own context for learning. In the light of this, we suggest that a more nuanced approach to the issue of contextualising learning could be productive, which takes into account the potential and limitations of technology enhanced learning, the importance of group work that connects learners and the ways in which learning situations are orchestrated. From this perspective contextualisation means constructing a 'safe enough' place which supports a feeling of being connected.

Within the domain of TEL two types of context utilisation can be distinguished: 1) using context for adaptation of educational systems and 2) using context to enable reflection and provide feedback to the learner. Part of the learning context can be the task given to learners, in the sense that it contextualises the learning objectives. For instance, if the learning objectives are about data collection and data analysis (statistics), classically learners do not have to formulate the problems, but are directly exposed to them: they have to carry out a series of statistics calculations on given data. Giving context would mean to provide a 'context' problem that does not state explicitly the 'statistics problem'. Examples of such a context problem are earthquake events (see http://www.evl.uic.edu/moher/) and a public health issue (see http://www.tel-laboratorium.fr/). In both these cases, the context includes a task and a simulation that immerses learners in relevant phenomena. Such simulations also provide opportunities for incidental learning, learning without explicit reference to instruction. On the one hand, they allow learners to make the original task their own as they are physically immersed in the phenomena. On the other hand, learners may focus on solutions and results rather than transferable strategies. Providing context for students in the form of rich learning experiences necessitates a phase of institutionalisation, a process by which the teacher makes sure that the knowledge constructed by the students within the context fits with the intended learning.

Mobile technologies offer great potential for contextualising learning. De Jong et al (De Jong et al., 2008) developed a reference model for mobile social software and used it to analyse the current

[12] http://www.accessmasterstour.com/masters/bologna-accord/index.html

state-of-the-art in such applications for learning. They provide examples illustrating the different context dimension used in mobile education.

Moreover ongoing research projects in the Higher Education sector are also focusing on the issue of context (e.g. Responsive Open Learning Environments, (ROLE)[13]). The idea is to develop personal learning environments (PLEs) that are highly contextual and adaptive depending on the learner's needs, preferences and skills. Using this approach, the PLEs are individualised in terms of the learning environment, combining tools and functionalities appropriate for each individual's circumstances.

Research questions include

- How does the ability of students to connect to the outside world while staying within the classroom affect teaching and learning?
- How do users respond to the flexibility and customisability of adaptive learning environments (Personal Learning Environments)?
- What sort of evidence could be used to investigate the extent to which personalised learning contexts contribute to learning?

2.3.2 Supporting the mobility of the learner

There are a number of different aspects to learning using digital mobile devices, often termed 'learner mobility'. The first relates to a provider focus, on supplying ubiquitous personalised access to resources and communication tools through mobile devices and associated networks (as for example in the discussion of PLEs in the previous section).

A second aspect focuses on the learner context, recognising that learning extends across time, space, and social interactions; with opportunities to support people to learn at work, at home and in the field, and also to connect learning in formal and informal settings and across life transitions such as moving from college into the workplace. Projects such as the Learning2Go,[14] Hand-e-learning, [15] and Myartspace (now commercialised as OOKL[16]) initiatives in the UK have shown that giving learners mobile devices enables a significant increase in the amount and type of information transferred between informal and formal learning contexts. These projects offer new opportunities for connecting learning in formal and informal settings, but there are barriers to be overcome, such as supporting teachers in developing new mobile learning practices and enabling museums and other cultural venues to provide or accommodate mobile technologies.

A third aspect concerns learning in a world of increasing mobility, with the need to understand new practices and ecologies of learning on the move and the design of technology-enabled learning spaces such as campuses and cities.

A fourth aspect focuses on mobility between real and virtual contexts. Pervasive and ambient technology in the learner's environment enable the virtual and real to be presented simultaneously to the learner. Context-relevant virtual information such as mediascapes and augmented realities are becoming increasingly available.

Mobile learning foregrounds the mobility of learners and learning (Sharples et al., 2005) and this raises the issue of the relationships between individuals, their learning contexts, their group, and society. The increasing number of students using Internet-enabled mobile devices means that tensions are forming as young people bring not only their personal technologies but also their technology-enabled social learning practices into classrooms and lecture halls. Mobility is also leading to mixed and multiple identities in different contexts. Helping learners to create, change and manage different identities is important and relates to what was discussed in the earlier section on connecting learning.

[13] http://www.role-project.eu

[14] http://www.learning2go.org

[15] http://www.bristolclcs.org.uk/index.php?_id=387

[16] http://www.cultureonline.gov.uk/projects/in_production/my_art_space/

Research questions include:

- What is the role of learner identity within 'mobile learning contexts', and how are transitions made and how can learning between and across contexts be supported?
- What are the issues from the point of view of students in moving between informal and formal and/or virtual and real learning contexts?
- How can the continuity of learning be supported across locations and life transitions?
- What is the potential of different mobile devices to contribute to learning? What are the limitations?
- How can mobile devices support or enhance assessment of learning in different contexts?
- What is the role of assessing and accrediting learning within non-formal mobile learning situations?
- What are the ethical issues of supporting and monitoring learning outside the classroom?

2.3.3 Standards for interoperability

The integrated use of TEL systems knowledge and contexts is still a complex and rarely well implemented scenario which needs further research. Representing knowledge in an interoperable manner among various TEL systems is a key element. Current user centred standards for usability and accessibility have a strong orientation towards addressing the modelling of user interfaces and devices.

Interoperability for TEL has been mainly developed concerning instructional design and resources, encompassing tools and roles. Within the community several specifications/standards of content exchange are used that allow for exchange of learning content between different platforms.

SCORM (Sharable Content Object Reference Model) was one of the first standards to be used for TEL systems interoperability. Its first version was mainly focused on content aggregation, the last one on activity sequencing on content objects (2004). LOM (Learning Object Metatada) was been set up in 2002 to describe and share learning objects within a LMS. Whereas LOM represented a first approach, no interoperable representation of domain elements was provided as the classification category left open the issue of an interoperable classification system.

A semantic Web approach provides an interoperable language (OWL) with a well-founded semantics that could be used to provide ontologies for describing content element in educational systems. There is a suggestion that we can usually find what we want (on the Internet). We have good search engines, so why is there a concern about interoperability? The argument is that search engine technologies are based on natural language, and while there is a recognition that they are usually good, they fail in some respects, for example if you search for a vehicle with two wheels in a natural language search engine, it is unlikely that (in the present state of the art) 'bicycle' will be returned. On the other hand, the semantic web is based on metadata which is concerned with providing computable semantics to data. A search using semantic web technologies would return 'bicycle' in the example above.

Representing competences is a way to solve the issue of annotating resources with a related domain content. More recently this has been tackled by a variety of projects, but some essential problems such as understanding the ways in which people work with competencies on a large scale and how to generate metadata easily still remain. For example the competencies used by the PÏSA studies (OECD) regarding mathematics, science and reading are very generic ones and are directly instantiated into questions and not into precise competencies. IMS Reusable Definition of Competency or Educational Objective Specification[17] is only a first step in competence

[17] http://www.openarchives.org/OAI/openarchivesprotocol.html#Introduction, http://www.imsglobal.org/competencies/index.html

interoperability, providing only textual descriptions, no computable semantics and no way of relating competencies to each other.

TEL systems and resources are now integrated into larger environments (contexts) and used outside the classroom. As such contexts play an important role in supporting the learning process, and interoperable representation of context becomes essential.

As recent projects in the e-content plus program applied in several application domains, key issues currently being researched include:Federation of distributed and fragmented content resources; Federation of existing content repositories via for example LOM application profiles, and harvesting and publishing protocols as OAI-PMH; Mapping of varying metadata formats and interpretations as also the development of a shared understanding and usage of different types of metadata, so as competence metadata (IMS-RDCEO); Integrated use of different classification and descriptions formats on competences, domains, usage metadata, and context metadata; Enrichment of federated repositories in active education usage as also the integration of metadata usage in instructional designs using it for "finding content"; Access to, and findability of, content, based on user-driven needs and intuitive visualisations; Sensemaking and usage of standards in PLE and web 2.0 driven learning environments as also mash ups.

There is also a need for standardisation in sensor networks. These should be interoperable but there are no standards and this means that different sensor networks work in different ways and hence cannot work together to realise the benefits of all networks. How could these be standardised and what might the implications of standardisation be for education?

Research questions include:

- For education settings, what do we think would be useful if interoperability were improved?
- Delivery in real time is a challenge (e.g. yahoo pipes). What is required in order to be able to achieve this? How would this enhance learning?
- Consider the idea of sharing resources and the idea of shifting context. Learners with mobile devices can move between contexts. What are the different aspects of context (e.g.location)?
- Why is it important to make different contexts interoperable?

3 Constructing the vision and strategy document

3.1 Methods adopted

The process of constructing this report started with a meeting in Lausanne in January 2008 when members of Kaleidoscope and Pro-learn met to discuss the possibility of developing an application for a new network of excellence within the FP 7 framework. Ideas discussed in this meeting were used and developed within the collective writing of the 'successful' application for funding (the Description of Work, or 'DoW'). It is from this meeting and the subsequent writing that the framework of three themes was developed. These themes were used as an organising framework for a face-to-face meeting in Bristol in May 2009 (month 4 of STELLAR), a meeting in which 33 members of STELLAR participated[18].

Within the Bristol meeting participants worked in groups to generate ideas and questions, organised around the three themes of STELLAR and related questions (all expressed within the DoW). A wiki (the Grand Challenges wiki) was created to enable people to capture the discussions at the Bristol meeting in writing. At the same time relevant vision and research documents and related research had been collected together and circulated around the STELLAR network to provide some stimulus material for discussion. Some time after the Bristol meeting STELLAR members were asked if they would like to become part of a small team who would coordinate the ongoing contributions to the wiki (to be called the D1.1 team[19]). This team actively engaged with the wiki, with sub-teams taking responsibility for coordinating the contributions to each of the three sections related to the three Grand Challenges. The D1.1 team provoked members of STELLAR to contribute to the wiki (overall about 20 people contributed to the wiki. Sometimes a contribution under one name represented a collation of several contributions from an institution.)

It was recognised from the start that using this approach to the production of a deliverable was risky, because it relied on individuals within the community to commit to the process. However, as a network, STELLAR subscribes to the idea of Science 2.0 as a way of working, and so we believed that it was important to experiment with such an approach.

In the final stages of creating the deliverable, two editors organised, structured and synthesised the content of the wiki, adding, in places, explanations, examples and references. This decision was partly related to time constraints but it may also relate to the need for intermittent periods of single authorship within sub-sections of a wiki. The final writing and editing of D1.1 was carried out in Word and not a wiki, because at least one of the authors finds it easier to get a sense of the 'whole' piece within Word rather than within a wiki. A draft document was sent to all of STELLAR for feedback and also to the two internal reviewers. All feedback was collated and taken into account in producing this final version of the document.

[18] Noaa Barak, Sally Barnes, Rosa Maria Bottino, Elizabeth Brown, Ulrike Cress, Fred de Vries, Cyrille Desmoulins, Claudio Dondi, Jean Dourneen, Sebastian Fiedler, Frank Fischer, Marina Gall, Denis Gillet, Eelco Herder, Lena Hofmann, Malte Jansen, Tim Jay, Marie Joubert, Barbara Kieslinger, John Morgan, Muriel Ney, Federica Olivero, Donatella Persico, Francesca Pozzi, Luigi Sarti, Peter Scott, Marcus Specht, Rosamund Sutherland, Sue Timmis, Katrien Verbert, Fridolin Wild, Caroline Windrum, Jocelyn Wishart.

[19] Nicolas Balacheff (UJF), Rosa Bottino (CNR-ITD), Frank Fischer (LMU), Lena Hofmann (LMU), Marie Joubert (UB), Barbara Kieslinger (ZSI), Stefanie Lindstaedt (KC) Stefanie Manca (CNR-ITD), Muriel Ney (UJF), Francesca Pozzi (CNR-ITD), Rosamund Sutherland (UB)

3.2 Reflections on the use of the wiki

Our aim is to keep the wiki 'live' throughout the lifespan of STELLAR and gradually open it up to members outside of the STELLAR network, starting with the STELLAR 'club'. In this section we reflect on our experience of using the wiki. Our aim is to explore what worked well and what worked less well, in order to inform future use of the wiki. The reflections here relate to the number of contributions made, to the 'quality' of the contributions and to wiki etiquette.

In terms of the number of contributions made, it seems that some members of the team were disappointed:

> 'We have done really our best to obtain inputs and feedback, but it has been a hard task' (email communication).

The team quoted above, who said that it had been difficult to get people to contribute, went on to suggest that it had been difficult because people were not motivated to contribute because they did not understand the origins of the wiki and did not know what its purpose was. Others suggested that they had not been aware of the wiki and the call for contributions, and yet others may have been reluctant to contribute because they did not feel sufficiently confident in their use of English. Some contributors provided chapters or papers as email attachments, but seemed to be reluctant to go onto the wiki and make direct contributions to the wiki at the appropriate places. Others appeared to be sceptical about whether something intelligent could be produced by working in this Web 2.0 way. A final possible barrier to contributing to the wiki may have been the technical difficulty of logging in to the wiki. We do not consider it to be very difficult, but it seems that some people found it confusing. For example, one STELLAR emailed to say:

> 'Unfortunately, it appears that I can't log in to edit it despite I can log in to http://www.stellarnet.eu/'.

In terms of the quality of contributions, there were some comments in face-to-face meetings that many contributions consisted of assertions but that these were frequently not backed up with examples, explanation or references to research literature. For example:

> 'With the growth of the Internet, and particularly Web 2.0, much learning takes place outside institutions'.

Finally, in terms of ways of working on the wiki and wiki-etiquette, there were some concerns about the extent to which it was appropriate to edit/modify/add to/delete the contributions of other people. Some people said that they do not like others to edit and change the text that they had written but others suggested that they were happy for others to edit their work. Many of those who did make changes seemed to feel the need to check the changes they had made with the original authors. For example:

> 'have done a bit of re-organisation, tell me if I am barking up the wrong tree'.

There was some debate about writing in the wiki as opposed to writing in a word processor. There were some who thought that it was much easier to do the latter, but others who argued that this meant that the full authoring trail would be lost.

Further, some contributors remarked about the transparency of working on a wiki, where other people can see contributions as they are made. This relates to the complexity of the process of 'individual' writing which includes drafting and re-drafting, and which may mean that first attempts are later deleted, because it may be too naïve or perhaps refers to others in a non-ethical way.

We have described some of the tensions arising in building the wiki. However despite these challenges, it is important to emphasise that the majority of the text in Section 2 of this deliverable (i.e. D1.1) is based on the text that was created in the wiki. In other words the wiki has succeeded in bringing together the ideas of the STELLAR community. We continue to believe that a wiki is an appropriate tool for the community to build a collective vision and we intend to persevere with this approach, that is a Science 2.0 approach.

3.3 Lessons learnt and ways forward

Our vision, and the vision of the STELLAR network, is to find effective ways of overcoming fragmentation in the network. In part this means recognising the distinction between fragmentation (which limits research) and multiple perspectives (which have the potential to enhance research and the building of knowledge). We suggest that in the construction of this report we have explored ways in which to draw the network together through a) working collaboratively b) discussing TEL-related issues and c) beginning to develop an appreciation of others' perspectives. We have also begun the work of identifying key research questions within the three themes. This work will continue over the life of the project and will culminate in the final Grand Challenge Vision and Strategy Report (M40).

In terms of using the wiki as a collaborative writing tool for the development of the community's Grand Challenges, we suggest that STELLAR develops a set of principles related to how members of STELLAR can contribute to the wiki and to wiki-etiquette.

In keeping with the approach adopted in the construction of this report, we consider that it is important to draw on the knowledge and understanding of the STELLAR community to do this. To take the process forward, we propose that STELLAR organises a workshop with the aim of developing a code of practice for using Web 2.0 tools to construct knowledge.

Examples of questions that might structure the workshop include:

- Within a wiki to what extent are prompts necessary to encourage discussion? Is it possible to write text in such a way that it encourages others to contribute?
- How can we use the wiki discussion tab to develop debate and argumentation?
- Is it necessary to have a person or team of people with overall editorial control of the wiki or is this the responsibility of the whole community?

4 Research and Development Strategy for STELLAR

The scientific work of STELLAR centres around a range of instruments as set out in the DoW. These instruments were designed to enable the ongoing work of the network, informed by the visions and challenges set out in this report. These instruments contribute to the STELLAR Grand Challenge and Vision Strategy and the related ongoing work of the Grand Challenge wiki. Some of this has been explicitly planned for within the DoW, for example D1.1 will influence the Delphi studies within WP1.

Below are further suggestions for ways in which the STELLAR instruments could directly contribute to the STELLAR Grand Challenge and vision:

- *Podcasts* - we suggest that podcasts can be used to capture some of the ongoing debates and tensions that have been discussed in this document. For example a podcast could be used to expand the debate about the relationship between higher order skills and knowledge domains. Or a podcast could capture the discussion about what is meant by the metaphor of orchestration. We envisage that the podcasts will be produced by representatives of many sectors within TEL, and in particular there should be a gender balance and doctoral candidates should be included. Podcasts could also be used within the *meeting of minds* to engage participants in the issues raised in this document (for example, a podcast could address questions about the relationship between the hype associated with Web 2.0 technologies with respect to education and the actual impact of these technologies on educational practices). All of these podcasts could be hyperlinked to the Grand Challenges Wiki.
- Members of the *stakeholder community* could contribute to the Grand Challenge wiki, by engaging with the issues raised in this report. Their contribution could focus on the perspectives of users. Some might like to create their own podcasts to link to the wiki. They could use this report (or the wiki) to inform the *mobility programmes* they choose to become involved in.
- Themes to be developed for the *theme teams* and *incubators* could draw on this report. It will help them identify TEL-related areas of interest and may inform the ways in which they conduct their work. A mechanism should be found for people involved in these instruments to contribute to the ongoing wiki (this could be a condition of the award).
- This report could be the focus of a discussion group at the *Alpine Rendez-vous* where discussion might concentrate on some of the substantive issues within the report. We suggest that it would be helpful to focus on the 'connecting learners' theme as this will provide useful input for the first *RTST* trend report for which this is the lead theme. Mechanisms could be found for members of the discussion group to continue to develop the Grand Challenge wiki.
- The Grand Challenge wiki could be a central component of the on-line *Doctoral Community of Practice.* STELLAR believes that it is important to recognise the contributions of members of the STELLAR community and that the voice of doctoral candidates should be represented. It is possible that discussions taking place within the *Doctoral Community of Practice* may be added to the wiki.
- STELLAR-sponsored *Doctoral Academy Events* could use aspects of the wiki to identify areas of interest or areas which seem to be under-researched so as to inform the choices they make. Participants at these events will be encouraged to contribute to the Grand Challenge wiki.
- Hyperlinks can be provided to the *Open Archive and scientific dissemination portal* as it develops, and items on the archive can be used to inform the future developments of the wiki.

- Finally we need to understand more about what we mean by *Science 2.0* and how the infrastructures being developed within Work Package 6 can take into account the social issues related to constructing scientific knowledge with Web 2.0 tools.

5 Concluding remarks - ongoing challenges

We suggest that one of the most important aspects of this report has been the process of collectively developing problématiques for sub-themes within the STELLAR Grand Challenge. We use the word problématique to signify the important work that needs to be carried out at the beginning of a research process. Developing a problématique involves identifying research questions and analysing the background thinking to such questions. It involves questioning assumptions and understanding the complexity related to a research question. It involves making implicit thinking explicit through a process of discussion and writing. It involves exposing differences in perspectives as part of a process of building knowledge. And as Bahktin suggests plurality of ideas is an important aspect of developing knowledge.

> 'Baktin criticized the assumption that, if two people disagree, at least one of them must be in error. He challenged philosophers for whom plurality of minds is accidental and superfluous. For Bakhtin, truth is not a statement, a sentence or a phrase. Instead, truth is a number of mutually addressed, albeit contradictory and logically inconsistent, statements. Truth needs a multitude of carrying voices. It cannot be held within a single mind, it also cannot be expressed by ³a single mouth.² The polyphonic truth requires many simultaneous voices. Bakhtin does not mean to say that many voices carry partial truths that complement each other. A number of different voices do not make the truth if simply ³averaged², or ³synthesized.² It is the fact of mutual addressivity, of engagement, and of commitment to the context of a real-life event, that distinguishes truth from untruth'. (http://en.wikipedia.org/wiki/Mikhail_Bakhtin#Problems_of_Dostoyevsky.E2.80.99s_Art:_polyphony_and_unfinalizability, accessed 7th August 2009)

At the beginning of this report we drew attention to the fragmentation of the TEL community, pointing out that this fragmentation can possibly be explained by the different perspectives adopted within different research areas in TEL. From the beginning we aimed to somehow 'aggregate the wisdom of the crowds'. From a Bahktinian perspective it would seem that such aggregation must remain as a polyphony, that is the intertwining of multiple voices.

In bringing different communities together within STELLAR we should become aware of similar theoretical perspectives that influence research in seemingly different domains. For example within computer science it is known that at the level of the computer chip there are mathematical nonlinearities in the interaction between the components within a digital data-system which means that it is impossible to predict system-level behaviour" (Cliff et al., 2008, p.13). In this respect such data-systems are complex dynamic systems (Capra, 2002). Interestingly social scientists are also drawing on complexity science in order to explain dynamic interactions within teams in the workplace (Stacey, 1995) and within the classroom (Davis & Sumara, 2007). In using theories from complexity science to understand phenomena such as the interactions between computer elements, and the interactions between people we have moved away from the idea of 'central control'of phenomena. However in the case of people this does not imply that there is no role for a leader or a teacher, but it does imply a change in role and understanding this change is one of the challenges within technology enhanced learning research. This in many respects is the challenge that we have been facing in constructing this report through the generation of knowledge within a Web 2.0 tool.

In structuring this report around the three sub-themes of the STELLAR Grand Challenge it is inevitable that there are some important research areas that have been overlooked. In particular the issue of the digital divide is not currently foregrounded within the work of STELLAR. Selwyn and Facer (2007) argue for a "wholesale re-imagining of the digital divide as a social rather than 'simply' a technical or economic issue" (p 31). In this respect they have coined the phrase "digital divide 2.0". They go on to argue that "just as the digital divide is social as well as technical, so too will its solutions require collaboration across technical and social research, between education and social policy, between industry, community and public sector" (p 31). This we suggest could be an

important aspect of the work of STELLAR, that is understanding how issues of the ‘digital divide’ permeate all aspects of the STELLAR Grand Challenge.

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