Lifelong Learning and its support with new technologies

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Abstract
This chapter provides an overview about the use of new technologies for lifelong learning. While in the past learning technologies were mostly provided by educational institutions to support a specific lifetime or shorter learning episodes nowadays more personal technologies are used for lifelong learning to support self-organized learning. Four important developments are introduced in this chapter, namely open learner models and learning analytics, learning networks and networked learning, open educational resources and practices and last but not least mobile and contextualized learning. The state-of-the-art in these research fields is summarized and future potential and requirements for lifelong learning are highlighted.

Keywords
lifelong learning, technology-enhanced learning, learning networks, mobile learning, contextualized learning, open learner models, learning analytics, open educational resources, open educational practices

Introduction
Lifelong learning is a concept that integrates a wide variety of learning formats and is usually seen as education throughout the lifetime. Lifelong learning activities can happen in a formal context (organised by an educational institution), it can happen outside an educational institution (non-formal) or it can also happen accidentally and not planned (informal). Any purposeful learning activity undertaken on an on-going basis targeted at the increase of knowledge, skills and competences can thus be seen as lifelong learning. Longworth (2003) stresses the importance of lifelong learning for the 21st century due to global demographics, environmental imperatives, the pervasive access to information due to new technologies.
and the innovation speed in science and technology. Due to these factors it becomes more and more a necessity to not only equip people with knowledge in educational institutions but to also prepare them to update their knowledge, skills and competences and take responsibility for learning throughout their lifetime. The author identifies the dismantling of barriers for lifelong learning as important action point to be addressed by research and development activities and the society as a whole. Among others the author identifies the following barriers:

- Poor family culture of learning
- Lack of finance to participate in lifelong learning
- Learning providers not geared to the needs of learners
- Poor information services attracting people to learning
- Distance from educational provision
- Lack of facilities to study at home
- Perception that the benefits system discourages learning

These identified barriers are also confirmed by recent statistics from the Labour Force Survey of the European Commission (Eurostat, 2012). This survey shows that in Europe between 2006 and 2011 a decrease of participation in lifelong learning activities could be measured. Participants in this survey mention access, time, place and lack of personalisation as barriers to be involved in lifelong learning activities. This survey shows that there is a gap between societal relevance of lifelong learning and the daily practices of professionals. As an additional barrier of lifelong learning, an overall fragmentation can be added to the barriers reported above.

While learning technologies have been traditionally offered by educational institutions with a focus on supporting short learning episodes little attention has been given to support the complex array of contexts, lifespans and individual characteristics of learners. Koper & Tattersall (2004) argue that the time scales, episodic and multi-institutional nature of lifelong learning was not reflected in the mainstream learning technologies in the past.

In the field of Technology-Enhanced Learning (TEL) a number of research directions have been developed in the last years that help to address the problems lifelong learners are facing today. In this chapter I introduce the current state-of-the art of new technologies for lifelong learning. For this purpose I have selected four research topics that contribute to the dismantling of barriers for lifelong learning. These new technologies are open learner models and learning analytics, learning networks and networked learning, open educational resources and practices and last but not least mobile and contextualized learning. In the following paragraphs I introduce the current state-of-the-art in these research topics and discuss the contribution to addressing barriers for lifelong learning. Finally I provide an outlook on future research and development and implication for policy frameworks for lifelong learning.
Open Learner models and Learning Analytics

One of the challenges for the field of technology-enhanced learning is the modelling and recognition of the activities and contexts of learners. Since lifelong learners might constantly change their learning context, location, goals, learning environments and also learning technologies the recognition of the current situation of the learner with the goal to personalize and adapt the learning environment is a challenging but also promising research direction. A lifelong learner might start his day with the reading of a work-related textbook during travel on his tablet computer, continue during work with a discussion of a specific problem in a professional social network, and join in the evening an online master-class about a new topic where he would like to build his expertise. These shorter learning episodes during one day are a representative picture of lifelong learning as a whole. Learners are active in different learning contexts in different learning formats and with different learning technologies. The analysis, construction and recognition of the learner context have been treated traditionally under the topic of learner models from the perspective of adaptive hypermedia (AH) (Brusilovsky et al., 2007). Based on an analysis of activities and contexts of learners, algorithms have been developed that are able to predict the behaviour of a learner, to provide guidance for the learning process or to personalize the presentation of learning content. But there is one important limitation of this work. The data collection and reasoning over these data work well in closed contexts like a dedicated electronic learning environment (e.g. learning management system/course management system). But there are limitations when it comes to integrating data from different learning contexts as presented above. This problem has been discussed as the “open corpus problem” (Brusilovsky & Henze, 2007). Open corpus adaptive hypermedia do not work on a closed set of resources known at the design time but, rather, work on the assumption that the learning resources and learning context constantly change and evolve.

To address this problem and to enable personalisation several initiatives have been started for lifelong learner modelling. A learner model is the sum of all knowledge that a software system has about a learner. This model gets constantly updated during the learning activities and should thus reflect the current state of knowledge of learners. While traditionally learner models were rather closed and only used by the technological infrastructure recently open learner models have been proposed and evaluated that are presented to the learner. The current state of such a learner model is presented to the user and there are different ideas about the benefits and the management of such an open learner model. Bull & Kay (2010) describe independent open learner models as being fully controlled by learners instead of learner models controlled by a system or in a cooperative manner. This approach addresses the personalization barrier of lifelong learning on a technological level and gives learners control about their digital representation in a learner model.

Kay (2008) takes this approach one step further and proposes to link and aggregate learner models from different contexts into long-term learning models that integrate the different contexts of lifelong learners. Besides the issue of collecting and storing these data she also proposes to integrate representations of the lifelong learner models into the working contexts of lifelong learners. This direction is also explored in a relatively young research topic in the field of Technology-Enhanced Learning called learning analytics (Greller &
Drachsler, 2012). Learning analytics exploit the potential of available large data sets (about learners, courses, behaviour etc.) to provide feedback in the form of meaningful visualizations to different stakeholders (learner, teacher, organization). While several initiatives in the field remain in the traditional boundaries of educational segments or institutions, some authors propose a more open approach to learning analytics that is potentially useful in the context of lifelong learning (Buckingham Shum & Fergusson, 2012). Especially approaches in which learners’ activities are monitored and collected in a number of different technology-enhanced learning environments have the potential to help learners connect different learning contexts (Romero-Zaldivar et al., 2012). Open learner models and learning analytics represent thus new technological solutions that can help learners to connect their data from learning activities in different learning environments and contexts and contribute therefore to the dismantling of the personalisation barrier of lifelong learning.

Current research is focusing on effects of open learner models and learning analytics to increase awareness about the learning process itself and the effects on meta-cognition. On the other hand, the evaluation contexts chosen are mostly focusing on the context of educational institutions and the transfer of results to an authentic lifelong learning context cannot be done without limitations. One limitation for both approaches presented here is a relatively high visual literacy that is required to make use of the data representation provided. Therefor some of the issues of open learner models and learning analytics are related to advancement of visualization approaches for learner and learning activity data.

**Learning Networks and Networked Learning**

The networked society and the potential to use network effects for learning and competence development has motivated new initiatives to apply this potential to the context of lifelong learning. Koper, Rusman, & Sloep (2005) propose the following model of a learning network: “An ensemble of actors, institutions and learning resources which are mutually connected through and supported by information and communication technologies in such a way that the network self-organises and thus gives rise to effective lifelong learning”. Figure 1 shows this conceptual model (Koper & Tatersall, 2004).
The model consists at its core of collections of learning activities around a specific domain. Learners in this network are connected via their shared learning objective called the target and they can optionally receive assessment and certification. The authors derive several requirements for the technical development of learning networks for lifelong learning. These requirements are:

- Learners should be responsible for their own learning and they should be able to conduct learning activities in different contexts at the same time. Thus, learners should be put center-stage and should be able to act self-directed.
- The focus of the learning network should be to enable learning and not to support instruction.
- Learners should be enabled to connect formal, non-formal and informal learning activities.
- Learning networks should allow access to learning resources and activities from different providers.

This model has been translated into an architectural model to allow its technical implementation. While initially peer-to-peer technologies have been used for the implementation (Koper et al., 2005) later this model has been integrated based on the service-oriented architecture paradigm. A number of technical services have been developed to support learners in learning networks. The individual routes of learners through this learning network are called learning paths. To avoid unnecessary repetition and to support personalisation a positioning service has been developed (Kalz et al., 2007). This service has been built on the basis of the accreditation of prior learning and has used language technologies to approximate the position based on a similarity analysis between the learner portfolio and the learning resources in the learning network. Based on the
position of a learner in this network and emerging behaviour of other members in this network the next best learning activities can be recommended (Janssen et al., 2007). Drachsler et al. (2008) discuss the complexity and requirements of using recommender systems in learning networks. Recommender systems are a well-known approach for the recommendation of products or media items for users, but to use recommender systems in learning networks a more complex set of requirements is given due to interdependencies of learning resources and learning activities. The model of learning networks has been implemented, tested and extended by a number of technical services in the European project TENCompetence (Koper & Specht, 2008) and has been afterwards used as technical infrastructure for educational innovation projects in different countries.

Alternatively other authors have proposed the concept of networked learning. Networked learning is more loosely defined in comparison with the learning networks approach. Networked learning is regarded as learning in which information and communication technology (ICT) is used to enable connections between learners, learners and tutors, the learner and learning resources and the learning community as a whole (Goodyear, 2001). Recently more attention has been given to the role of online social networking platforms and their potential for learning and competence development. Veletsianos and Navarrete (2012) provide a literature review about the use of social networking sites for learning and present a case study to analyse the experiences made by students in a course delivered via a social networking site. The study showed that learning in social networks can help to decrease problems of isolation and lack of support in networked learning contexts. Due to the widespread adoption of social software and social media their potential for lifelong learning has been explored from the perspective of self-directed learning. Dabbagh and Kitsantas (2012) propose the use of personal learning environments in combination with social media to allow learner three type of activities that are important for self-organized learning. In their framework the phases of personal information management, social interaction and collaboration and information aggregation and management play a central role.

The approach of learning networks and networked learning has been applied in a number of contexts. These case studies have mostly been implemented in a professional development context to allow professionals a flexible and self-directed access to learning resources and experts in the profession. A limitation for learning in learning networks and networked learning is that a relatively high level of self-organization and at the same time technology literacy is needed to be able to organize one’s learning process based on a combination of tools.

To sum it up: Learning networks, networked learning and approaches based on the use of social networking platforms, social software and social media offer new contexts for lifelong learners to learn regardless of time and place and to be active in a social context while focusing on self-organized learning. These new technologies contribute thus to the dismantling of the barriers time, place and personalisation for lifelong learning but also need a relatively high level of technology literacy and self-organization competences. They have the potential to address the fragmentation problem of lifelong learning, but on the other
hand the networked approach is mostly not leading to centralisation but to a complex array of tools and resources.

**Open Educational Resources and Open Education**

One of the developments that specifically contributed to decrease the accessibility barrier of lifelong learning is the trend to publish learning resources as open educational resources (OER). While traditionally learning resources have not been made available to the public several initiatives have been started in the last 10 years that have focused on making learning resources publicly available. These initiatives have partly been motivated by the need to increase student recruitment, to maximise access to learning resources also for disadvantaged communities of learners and finally to give to the public what has been paid by the public. The last argument is stemming from a wider discussion about open access for scientific work financed by public resources.

The Organisation for Economic Cooperation and Development (OECD) Centre for Educational Research and Innovation (CERI) argues that OER are governmental means to support lifelong learning representing a cost-effective way to ensure access to a diverse set of learning opportunities (OECD, 2007). The OER initiatives have been conducted in three different cycles. Initially, some large higher education institutions like MIT have started to publish learning resources without charging access fees publicly on the Internet. Several other institutions followed this example. This vast amount of resources available on different platforms has motivated a second stage of development in which the access and search of domain specific open educational resources has been targeted. Several technical standards have been developed to ensure that learning resources are accessible by end-users (Klemke et al., 2010). A third stage has changed the focus again from the resources to the learning process as a whole to enable open educational practices (Kalz et al., 2008). While the first and second stage have primarily focused on making isolated and reusable learning resources available and accessible, the third stage was motivated by the need of learners for an educational framing and the embedding of the learning resources in a wider learning process and context. Geser (2007) has stressed in the roadmap deliverable of the Open eLearning Content Observatory Services project (OLCOS) the need for new educational practices that go beyond OER use and re-use. The embedding of OER in competence-focused, collaborative knowledge acquisition scenarios is sketched as a promising future scenario to let open educational practices emerge. Recent research and development projects have not only made OER available, but also offered new technical services to integrate these learning resources into individual competence development trajectories or have enabled the reuse of learning resources with social media (e.g. Kalz et al, 2010). Thus OER can potentially be used in self-directed learning scenarios as described in earlier paragraphs.

In general Open Universities around the world have a long tradition to offer open learning opportunities to diverse audiences. But the Internet and Open Educational Resources have enabled new actors to be active in the field of open distance learning. More recently the concept of ‘Massive Open Online Courses’ (MOOCS) has been intensively discussed. This new format is a continuation of OER initiatives but with a focus on enabling open
educational practices. Daniel (2012) discusses critically this new educational format and he stressed the adaptation of the original model of MOOCs. While the initial idea of MOOCs was centred on networked learning and co-creation of knowledge recently several campus-based institutions have taken the initiative to implement their own MOOC concept. In this case the MOOC concept has been implemented based on an instructional paradigm with a focus on knowledge transmission via recorded lectures.

The scholarly discussion is in a very early state about this format. Nonetheless, the speed of adoption of MOOCs has again contributed to the diversification of learning resources available to the public without access costs. While both concepts of OER and MOOCs focus on enabling open access to learning resources and learning activities, there are potentials and limitations for both concepts. The idea of Open Educational Resources was not only to provide open access but also to allow adaptation of the published material under a licensing scheme like Creativecommons. This licensing scheme enables producers of digital resources to implement a fine-grained regulation of the reuse and adaptation allowed for their resources. This has enabled other teachers and learners to use existing material instead of developing something from scratch. Through the reuse goal, the resources published were mostly as context-neutral as possible to allow the adaptation for different contexts. The assumption for reuse of OER was that these resources are found, adapted and integrated into a new learning context. The situation for MOOCs is exactly the opposite: While both formats allow open access, the idea of reuse of OER is not given in the MOOC context. Instead, the focus of MOOCs is rather on co-creation of knowledge without a focus on learning content, or the implementation realizes a classical lecture-based model that follows a classical instructional paradigm without any reuse of resources.

To sum it up: Open Educational Resources and Open Education have addressed the accessibility barrier and the financial barrier for lifelong learning. A number of initiatives have shifted from open access and reuse of resources to enable new open educational practices. While the scholarly discussion about the effects of these new approaches is not yet mature, these initiatives increase the diversification of opportunities for lifelong learning.

**Mobile and Contextualized Learning**

The pervasive use of mobile devices on a global scale and in nearly all contexts of life has contributed to a growing interest in mobile and contextualized learning scenarios. While mobile learning has been regarded in its early years from a technocentric perspective later the focus shifted more to the mobility of the learner (Traxler, 2009). The main benefit of mobile technologies is their availability when learning and learning needs occur to people. Thus it enables people to connect their fragmented learning experiences to their long-term learning goals. This aspect offers opportunities to connect on the one hand the unconnected learning contexts of lifelong learners, on the other hand mobile and contextualized learning scenarios can bridge also the work context and the learning context. This bridging function of mobile learning has been described by Wong and Looi (2011) as a research agenda for seamless learning. A seam is always given when there is a change in the context of the
learner. In this research agenda the following seams are identified that mobile and contextualized learning should address:

- Encompassing formal and informal learning
- Encompassing personalized and social learning
- Learning across time
- Learning across locations
- Ubiquitous knowledge access
- Encompassing physical and digital worlds
- Combined use of multiple device types
- Switching between multiple learning tasks
- Knowledge synthesis
- Encompassing multiple pedagogical or learning activity models

These issues have also an impact on how lifelong learning is organized and conducted today and many seams of this research agenda are directly related to the barriers identified earlier.

Sharples (2000) argues that lifelong learning is always situated, can focus on different learning activities and can happen in different learning contexts. Tools that support lifelong learners should therefore be highly portable, individual, unobtrusive, available, adaptable, persistent, useful and intuitive. He discusses the convergent development of personal technologies and the changing notion of lifelong learning. Table 1 presents the convergent development of new communication technologies and lifelong learning (Sharples, 2000).

<table>
<thead>
<tr>
<th>Lifelong learning</th>
<th>New technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualised</td>
<td>Personal</td>
</tr>
<tr>
<td>Learner centred</td>
<td>User centred</td>
</tr>
<tr>
<td>Situated</td>
<td>Mobile</td>
</tr>
<tr>
<td>Collaborative</td>
<td>Networked</td>
</tr>
<tr>
<td>Ubiquitous</td>
<td>Ubiquitous</td>
</tr>
<tr>
<td>Lifelong</td>
<td>Durable</td>
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Table 1: The match of new communication and information technology to lifelong learning (Sharples, 2000)

In a recent-meta analysis of mobile learning it has been shown that most studies in the field are conducted in higher education institutions and elementary schools (Wu et al., 2012). This means that the lifelong learning context is not yet in the focus of attention despite the convergence of requirements for lifelong learning and the development of new personal technologies.

To enable the vision of seamless learning experiences the core question is which key parameters influence the learning processes, and which are the technical consequences for developing mobile solutions to support a seamless learning experience. Beside appropriate educational content, contextualization, personalization, interaction, awareness, and reflection are the main aspects to realize seamless learning experiences. Recently non-formal, informal learning contexts and authentic problems have been explored in the mobile and contextualized learning field. In addition, the focus on mobile devices is also shifting to a
whole group of personal technologies that could potentially be used in the lifelong learning context (Specht et al, 2012).

To sum it up: Mobile and contextualized learning and the use of personal technologies have the potential to directly contribute to the dismantling of fragmentation of lifelong learning activities. They support the mobility of learner and contribute to time and place-independent access to learning resources and activities. Several case studies from disadvantaged learning communities show that they also have the potential to also address the lack of study facilities at home.

**Connecting the dots of technologies for lifelong learning**

The following table maps the new technologies introduced with the most important barriers.

<table>
<thead>
<tr>
<th>Barrier for Lifelong Learning</th>
<th>New Technology</th>
</tr>
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<tbody>
<tr>
<td>Lack of finance</td>
<td>Open Educational Resources/Open Educational Practices</td>
</tr>
<tr>
<td>Lack of personalisation</td>
<td>Modeling of Lifelong Learning/Open Learner Models &amp; Mobile and Contextualized Learning</td>
</tr>
<tr>
<td>Time/Place</td>
<td>Learning Networks/Networked Learning &amp; Mobile Learning</td>
</tr>
<tr>
<td>Lack of facilities to study at home</td>
<td>Mobile and Contextualized Learning</td>
</tr>
<tr>
<td>Fragmentation</td>
<td>Mobile and Contextualized Learning/Learning Networks and Networked Learning</td>
</tr>
<tr>
<td>Health/Age</td>
<td>Open learner models and accessibility tools</td>
</tr>
</tbody>
</table>

Table 2: Mapping of lifelong learning barriers and new technologies

Although these developments have all their individual value for addressing the barriers for lifelong learning, serious improvements for a large amount of individuals will be only visible if these innovations are connected. At the moment these topics and technological developments are still treated relatively independently from each other – sometimes even in different scientific communities.

Besides these different problem areas there is also a time perspective in the challenges for technological support of lifelong learning activities. In the third age of life (also called “older adulthood”) new requirements for learning can arise through specific health conditions. On the one hand these requirements can be addressed by following so-called web accessibility guidelines (WAG), on the other hand the target group of learners in their later lifetime has different cognitive abilities and attitudes towards use of new technologies (Czaja et al., 2006). Personalization approaches for this target group have to take into account these specific requirements. Therefore, recently new initiatives have been started with a focus on providing learning opportunities for elderly people. These initiatives do not only focus on the acquisition of new skills or knowledge but there is also a trend to develop learning technologies to maintain cognitive abilities.

But these connections can only emerge if there are on the one hand policy frameworks that support and foster lifelong learning for large parts of the society, and, on the other hand,
new business models are developed for companies that support learners in lifelong learning or institutions in making their learning activities accessible and compliant with requirements of lifelong learning. One of the largest framework programs to foster the advancement of lifelong learning is the Lifelong Learning Program by the European Commission. This framework needs to be combined with national initiatives to balance the societal relevance of lifelong learning and the participation in lifelong learning activities by a large part of the society.

**Conclusions and Outlook**

In this chapter I have provided an overview about recent developments with regard to using new technologies for lifelong learning purposes. These new technologies help to dismantle barriers for lifelong learning. An overall challenge for the development and evaluation of technology for lifelong learning is the evaluation context: While the context of lifelong learning is described as being episodic and multi-institutional, most evaluations context lack this important feature and thus scientific evidence is collected in the context of educational institutions and in a relatively short timespan. In the future, more field studies and long-term evaluation scenarios are needed that focus on mobility problems and seamless learning experiences of lifelong learners in authentic contexts.

Another challenge for the use of new technologies for lifelong learning is the level of self-organization and self-directedness required to use these technologies to organize one’s own learning. While educational institutions have an emphasis on knowledge transfer, more emphasis must be spent on the use of new technologies for self-directed learning. This issue is seen as one of the key skills for our society, but educational institutions have not yet adapted to prepare people not only for a life as professional, but also for a life as lifelong learner.

**References**


List of Relevant Websites

Creativecommons: http://creativecommons.org
