Mobile learning – a new paradigm shift in distance education?

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Those who do not remember the past are condemned to repeat it.
(George Santayana, 1863-1952)

Abstract

During recent years, many distance teaching as well as residential institutions have started to experiment with mobile learning through pilot projects as part of their e-learning and technology enhanced learning environments. Mobile learning should not be regarded as a medium for distance learning. However, because of the similar affordances of distance learning technologies and online and mobile learning, the established field of distance education can provide valuable insight into strategies, approaches and practical experiences with regard to the conception and organization of this new medium for learning. Distance teaching institutions have a long history and much experience with media-based instruction. This affords them an advantage in the development and application of new information and communication technologies (ICTs) for teaching and learning. Student support systems have existed in traditional distance education for decades. ICTs – especially mobile devices – open up new paths for learning support and opportunities to reach a wider audience for (higher) education. However, will mobile learning bring about a paradigm shift in distance education? Or is it perhaps a new generation of distance education? Does it afford new opportunities for teaching and learning in terms of access and flexibility? This paper reports on an international survey that was conducted amongst distance educators in order to explore these questions.

Contents

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1 Introduction

Mobile learning is in many ways a new phenomenon and its theoretical, pedagogical, organizational and technical structure is currently still developing (Brown, 2004). Many distance teaching as well as residential institutions have already started to experiment with mobile learning through pilot projects as part of their e-learning and information and communication technology (ICT) enhanced learning environments. Because of the similarities between distance educations, online and mobile learning, the established field of distance education can provide valuable insight into strategies, approaches and practical experiences with regard to the conception and organization of this new medium for learning. Distance education can review over 150 years of experience with media-based instruction (Gladieux & Swail, 1999): "Today's virtual instruction has its roots in correspondence schools" (p. 9). Distance teaching institutions are therefore at a clear advantage in the development and application of new ICTs for teaching and learning. However, it can be observed that many speakers at conferences or vendors of cutting-edge technologies often neglect the link between new ICT tools or devices and the lessons learnt in distance education, which have to be considered in order to avoid mistakes from the past.

The experience of distance education shows that learning support for students is of decisive importance for successful distance study (Brindley & Paul, 1996; Zawacki-Richter, 2004). Student support systems in various forms have existed in traditional distance education for decades. ICTs – especially mobile devices – open up new paths for learning support and opportunities to reach a wider audience for (higher) education.

In the light of the above pattern of thought, does the emergence of mobile learning imply a new generation in distance education or even an educational paradigm shift? Does it afford new opportunities for teaching and learning in terms of access and flexibility? The aim of this paper is to explore mobile learning as a new field of pedagogical activity.

Development rising arisen

2 From print to wireless

2.1 The emerging concept of mobile learning

Landline telephones and wired computers are beginning to be replaced by wireless technologies. Desmond Keegan emphasized in his keynote address at the World Conference on Mobile Learning 2005 in Cape Town that "The future is wireless. […] Never in the history of the use of technology in education has there been a technology that was as available to citizens as mobile telephony. The statistics are stunning: Ericsson and Nokia tell us there are 1.5 billion of them in the world today for a world population of just over 6 billion. Nokia forecasts further sales of 700 million in 2005. In China alone there are 358 million mobile subscriptions and these are reported to grow by 160.000 a day (p. 3). Seventy seven percent of the world's population is within reach of a mobile phone network (Kukulska-Hulme & Traxler, 2005).

Because of the lack of infrastructure for ICTs in developing countries (for example, cabling for the Internet and telecommunications), the growth of wireless infrastructure is developing even more rapidly. Between 1997 and 2001, the number of mobile phone subscribers in Africa for example, had an annual triple-digit growth rate (Shapshak, 2002). In 1999 Tokyo had more telecom connections than the whole of Africa combined, yet by 2003 Africa had twice as many as Tokyo (Gourley, 2004). Mobile subscribers in Africa increased by over 1000 % between 1998 and 2003, to reach 51.8 million (ITU, 2004).

Educators started experimenting with wireless and mobile technologies from the turn of the millennium and the concept of mobile learning began to emerge. There is currently globally a rapid rate of development and application of wireless and mobile technologies in contemporary learning environments and learning paradigms. Apart from mobile phones, other wireless and mobile computational devices such as laptops, palmtops, PDAs (Personal Digital Assistants) and tablets also rapidly entered the market – some devices, of course, have exhibited more success than others for particular markets. Keegan (2003) presents and analyses no less than 30 mobile learning initiatives across the globe in 2001. In such initiatives much has already been done about the experimental use of

wireless technologies (including wireless Internet environments and wireless classrooms) and various mobile devices for teaching and learning. Kukulska-Hulme and Traxler (2005) provide a dozen detailed case studies that report on the experiences of pioneer educators around the world who have experimented with mobile technologies in universities and colleges and in commercial training. They explore user experience with mobile devices, accessibility, pedagogical and institutional change, and current technology. With regard to the potential of mobile learning in developing countries, Brown (2004) argues that Africa is leapfrogging from an unwired, (almost) non-existent e-learning infrastructure, to a wireless e-learning infrastructure. There are already many mobile learning activities and projects in Africa – from the use of PDAs in assessment strategies (e.g. the clinical assessment of medical students) and PDAs in wireless learning environments (e.g. engineering students for collaboration and coursework) to the use of the most basic mobile texting functionality (SMS) for learning support (Brown, 2006).

2.2 Mobile learning in the context of distance education and flexible learning

Over the past decade we have become familiar with the term 'e-learning' and now the concept of 'mobile learning' is emerging. What then, is the relation between the two notions?

The all-inclusive umbrella term for media-based learning and teaching is distance education or distance learning, which is characterized by "the quasi-permanent separation of teacher and learner throughout the length of the learning process" (Keegan, 1986, p. 49). The central concern of distance teaching pedagogy is to bridge the distance: "Because the distance to students was regarded as a deficit, and proximity as desirable and necessary, the first pedagogic approaches specific to distance education aimed immediately at finding ways by which the spatial distance could be bridged, reduced or even eliminated" (Peters, 2001, p. 18). E- and mobile learning provide enormous possibilities for closing the gap between learners and teachers or the teaching institution, to overcome the misconception of distance learning as an isolated form of learning.

In general, e-learning means learning with electronic media, i.e. via the Internet (intranet or extranet), but also via television and radio, audio and video tapes and CD-ROM. E-learning is therefore defined more narrowly than distance learning, which includes print-based study materials and correspondence communication. E-learning can therefore be regarded as a subset of distance learning, but not vice versa (Rosenberg, 2001). The printed materials which are widespread in distance learning should be understood here as a form of technology as well. The following comprehensive definition of Urdan and Weggen (2000) provides a sufficient basis to distinguish between mobile learning and e-learning: "The term e-learning covers a wide set of applications and processes, including computer-based learning, Web-based learning, virtual classrooms and digital collaboration. We define e-learning as the delivery of content [and interaction] via all electronic media, including the Internet, intranets, extranets, satellite broadcast, audio/video tape, interactive TV, and CD-ROM. Yet, e-learning is defined more narrowly than distance learning, which would include text-based learning and courses conducted via written correspondence" (p. 8).

Mobile learning can be viewed as a subset of e-learning. E-learning is the macro concept that includes online and mobile learning environments. Online learning facilitates communication and collaboration via networked computers.

For the purpose of this paper we conceptualize mobile learning as a subset of e-learning; that is, e-learning is the macro concept that includes online and mobile learning environments. In this regard the following simple definition by Quin (2001) is useful: "M-learning is e-learning through mobile computational devices" (p. 1). Mobile learning devices are defined as handheld devices and can take the form of personal digital assistants, mobile phones, smartphones, audio players (such as the Apple iPod), video and multimedia players, handheld computers and even wearable devices. They should be connected wirelessly, thus ensuring mobility and flexibility. They can be stand-alone and possibly synchronized periodically, intermittently connected to a network, or always connected (adapted from http://www.mlearnopedia.com/index.html).

The extended opportunities for communication and interaction afforded by the new media lead to a convergence of the pedagogic structures for distance learning and campus-based face-to-face learning with regard to support for learners and the practice of teaching and learning (Mills & Tait, 1999; Collis

& Moonen, 2001). More and more universities are offering courses in which phases of face-to-face teaching alternate with guided online studying. In this context, terms such as 'blended learning' (Sauter & Sauter, 2002), 'flexible learning' (Collis & Moonen, 2001) or 'distributed learning' (Lea & Nicoll, 2002) are becoming prevalent. A continuum is coming into existence between the two poles of campus-based and distance learning.

Brown (1999) describes flexible learning as "a macro concept and education philosophy that focuses on student centredness, learning centredness and flexibility in terms of learning environments and learning opportunities. The international trend is that successful and effective tertiary education is linked to the creation of student-centred flexible learning environments that provide for flexibility in terms of: access to and exit from several learning programmes; accreditation and portability of qualifications; modes in which education takes place; modes in which communication and interaction take place; programme compilation; study material; evaluation and assessment methods; time and place of study; and pace at which learning takes place. [...] [Flexible learning] refers to a mixed or multimode of education that includes all modes of contact and distance education, as well as all possible combinations thereof" (p. 1).

Figure 1 visually portrays the relation between mobile learning, e-learning, distance learning and flexible learning.

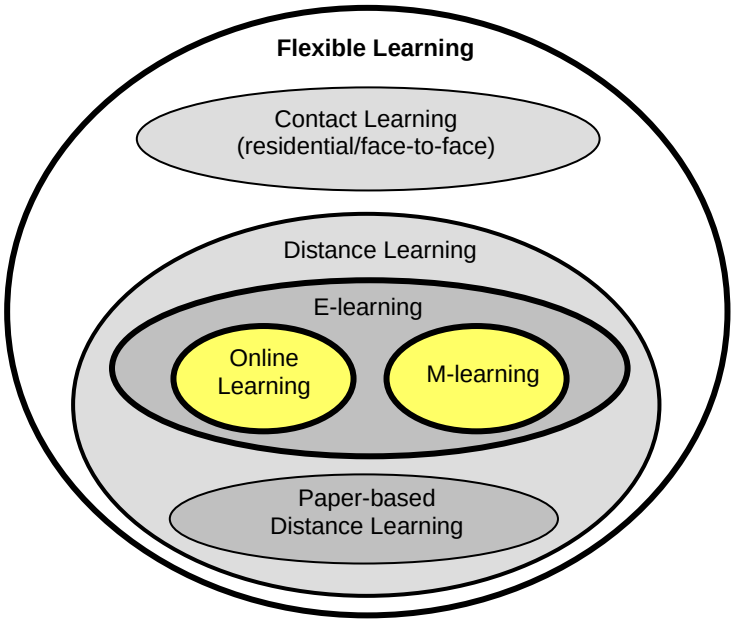

Figure 1: The subsets of flexible learning (Brown, 2005)

2.3 Generations of technological innovations in distance education

To further explore opportunities that mobile learning affords, we have to build upon previous generations of technological innovations, in order to benefit from the lessons learnt in distance education.

Garrison (1985) distinguishes three generations of technological innovations that initiated a paradigm shift in distance education. The term 'paradigm shift' in education refers to the changes in teaching and learning as a consequence of the tremendous impact of technological advances (Peters, 2004): "A paradigm shift in education might mean that in education certain models or patterns no longer exist, because new models and patterns which differ from the old ones in a marked way have substituted them. This means that, very often, we are not dealing with a transitory process in the field of education under investigation but with a sudden, if not with an abrupt change" (p. 25).

Media are described by Garrison (1985) as a function of interaction and independence. He identifies three milestones of technological innovations, namely print media (correspondence generation), telecommunication technologies (telecommunications generation) and the personal computer

(computer generation). Other media that are not considered to have significantly altered the delivery of distance education are so-called ancillary media, e.g. radio and television broadcasts, audio or video cassettes. Such media are not capable of providing two-way communication, which is widely accepted as a constituent element of distance education (cf. Keegan, 1986).

Garrison's generations are an established concept that has been further developed with the emergence of new media, especially the Internet, since the 1980s by other authors such as Nipper (1989), Taylor (1995), Taylor (2001) or Srivastava and Reddy (2002). The term 'generation' has been criticized since it implies the end of one phase and the beginning of another. However in distance education, an 'old' generation does not fade out, but technological advancements build upon each other to open new channels of learner support and two-way communication.

Access, flexibility and costs have been described by Daniel (1998) as major attributes of distance education. Distance education is capable of offering access to education for high numbers of students, independent of time and space, at low costs through economies of scale (mass higher education). Hülsmann (2000) highlights the economic strength of open and distance learning: "Distance education is associated with comparatively higher fixed costs and lower variable costs. It needs more substantial investment up front for course development but these costs are then spread over an increasing number of students. […] As student numbers increase, so the fixed costs can be shared among an ever-growing number of learners, thus gradually reducing the average cost per student. Provided that the variable costs of distance education – for tutoring or the distribution of materials in particular – can be held down, it may therefore bring economies of scale" (p.30).

The media applied in distance learning influence the form and nature of interaction and communication, the level of independence and flexibility, as well as scalability and therefore access and costs of distance learning courses.

In the following sections we analyse the development of distance education according to Garrison's (1985) three generations with regard to the attributes emphasized above:

- Correspondence generation (since the 1850s),
- Telecommunications or Open University (OU) generation (since the 1960/70s), and
- World Wide Web (WWW) generation (since the 1990s).

2.3.1 Correspondence generation

The roots of distance education date back over 250 years. The first generation was print-based correspondence education. Battenberg (1971, p. 44) mentions the 'lessons' advertised in the Boston Gazette in 1728 by Caleb Philipps as the first milestone in distance education. In Europe, Gustav Langenscheidt founded his publishing house in 1856 and, together with his colleague Charles Toussaint, offered self study language courses in French. These lessons became famous because of the phonetic alphabet (méthode Langenscheidt-Toussaint) that was developed to teach French pronunciation via print-based study materials. Strictly – according to the criteria defined by Keegan (1986) – these early forms of correspondence courses cannot be considered as distance education because of their non-interactiveness. Two-way communication (i.e. tutorial support via letters) is known from the Institute of Correspondence Education (Abteilung für brieflichen Unterricht) of Simon Müller in 1897 in Berlin (Delling, 1992, see Figure 2).

The University of London was the first university that offered correspondence courses in 1858 for emigrants in the colonies of the British Empire. Effective learner support was non-existent: study materials were simply sent off via a post ship, together with a syllabus and a list of examination places and dates (Ryan, 2001): "It left any 'learning' to the hapless student, who sat the examination whenever he or she felt ready: a truly 'flexible' schedule!" (p. 71). The first dedicated distance teaching university was founded in 1875: the University of South Africa (UNISA) in Pretoria.

Correspondence education afforded maximized flexibility and access through independence of time and space. However, the autonomous, self-directed learner does not exist per se. Therefore, the dominant one-way communication, i.e. the dispatch of pre-prepared study materials, was supplemented by two-way communication, e.g. by means of face-to-face sessions, tutoring via letters, or the telephone. However, the opportunities for, and effectiveness of learner support were limited.

Response times were long, since communication depended on the postal system via railway or post ships.

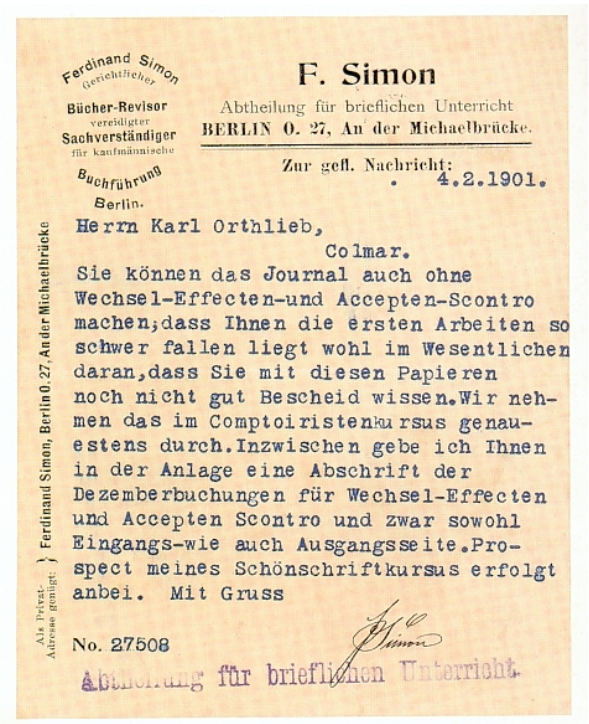

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Figure 2: Tutoring in correspondence education in 1901 (Delling, 1992)

Print-based distance learning is still the most prevalent form of distance education, because the mega-universities with several hundred thousand students (Daniel, 1996) rely on the scalability of print-based distance education (mass higher education). Furthermore, print-based distance education is the only possible way to reach target groups (e.g. learners in rural Africa) that have no access to a computer or e-mail.

First generation distance education was characterized by limited and extremely slow interaction (two-way communication via letters). Contact with other learners was only possible through contact sessions and therefore almost impossible for most students.

2.3.2 Telecommunications or OU generation

The second generation in the development of distance education is closely linked with the foundation of Open Universities in the late 1960s and early 1970s, e.g. the Open University UK in 1969, which serves as a model in this field. Dedicated distance teaching institutions applied instructional design methods systematically to produce sophisticated, high quality study materials (cf. Schreiber, 1998).

Another new development in second generation distance education was the establishment of study centres as an important element of the student support system (Tait, 2000). Such centres provide access to educational technologies such as video-conferencing, study materials, library services, learning groups and personal counselling (Tait, 1995).

Telecommunications and electronic media facilitate communication in terms of audio, video and text information via telephone, fax, television, video, radio as well as audio-, video- and computer-conferencing. The telecommunications generation is therefore also called 'multimedia distance teaching' (Nipper, 1989).

Garrison (1985) emphasizes the importance of computer assisted learning (CAL). CAL programmes are self study materials that should maximize interaction and independence. In this regard, interaction is seen as a form of internal interaction, i.e. between the computer-based learning programme and the learner: "Consideration of CAL's potential in distance education requires going beyond the restrictive

view that interaction is mediated person to person communication" (p. 238). However, experience has shown that programmed instruction without social interaction and dialogue between learners and teachers, and among learners, is not very successful (cf. Schulmeister, 1999; Wessner, 2001). CAL programmes can, however, be a meaningful supplement to the distance education package.

In an audio- or video-conferencing, learners can communicate synchronously. Long response times, as in correspondence education, are reduced dramatically. However, the technology requires a great deal of expensive equipment that has to be provided by a local study centre, which means that students cannot participate without visiting the study centre at a fixed time. Therefore, access and flexibility are limited. Daniel (1998) even speaks of a triple crisis of access, cost and flexibility: "Group teaching in front of remote TV screens? This is not only an awful way to undertake distance learning, but flies in the face of everything that we have learned while conducting successful open and supported learning on a massive scale for the past 27 years. Our lessons are the key to addressing the triple crisis of access, cost and flexibility now facing higher education world-wide" (p. 21).

2.3.3 WWW generation

Murray Turoff from the New Jersey Institute of Technology developed computer-mediated communication (CMC) and the CMC-based learning environment 'Virtual Classroom' (Turoff, 1995; Hiltz, 1995). At the Open University UK the 'CoSy' (conferencing system) was introduced for online tutorials as early as 1988 (Mason, 1989). Today, powerful learning management systems have emerged from those early forms of CMC systems.

The big breakthrough of CMC was facilitated through the massive distribution of personal computers and the development of the World Wide Web in the 1990s. Access to information and communication independent of time and space became possible through the availability of networked computers – in this way interaction and independence were reconciled with each other.

Isolation has been seen as a major problem in distance education (Brindley & Paul, 1996): "Distance learning can be very isolating, and inadequate attention to course design, student counseling and support can yield poor completion rates and the worst aspects of one-way knowledge transmission" (p. 43). The most valuable benefits that modern ICTs can bring to distance education are flexible, inter-personal two-way communication and tools for collaborative learning: "The availability of learners to each other and to the tutor asynchronously as well as synchronously, has the potential to overturn the emphasis on distance education as an individualized form of learning" (Thorpe, 2002, p. 114). The issue of access to synchronous audio- and video-conferencing mentioned under second generation distance education can nowadays be solved through virtual classrooms such as Centra or Macromedia Breeze, where various synchronous and asynchronous communication and presentation media converge in one web-based learning environment.

In contrast to CMC as an add-on to learner support, in the wholly integrated online teaching model (Thorpe, 2001), "the tutors of the course carry authority to create the detailed course teaching as it progresses over the duration of the course, rather in the way a conventional university lecturer does" (p. 17). Tutors must not only be subject matter experts, but they also need more advanced skills in online communication and moderation than the conventional tutor in a second generation distance education course. A possible drawback of such interactive online courses that are facilitated by subject matter experts or moderated by online tutors or 'e-moderators' (Salmon, 2000), is limited scalability. The advantage of lower initial production costs of such courses is dissipated by higher course presentation costs (tutoring).

Taylor (2001) seeks to solve the cost dilemma with intelligent automated tutor systems in his fifth generation: "In contrast, fifth generation distance education has the potential to decrease significantly the costs associated with providing access to institutional processes and online tuition. Through the development and implementation of automated courseware production systems, automated pedagogical advice systems, and automated business systems [...]" (p. 4). However, learner support via computer-generated automated feedback reminds us of programmed instruction, which proved not to be very successful, especially for higher order learning. Furthermore, the status of research in artificial intelligence remains far from ready for the application for tutorial feedback systems in practice.

2.4 Mobile learning: the next generation?

Soloway (2003) remarked that: "For the first time in ICT history, we have the right time, the right place and the right idea to have a huge impact on education: handheld computing" (p. 2). The increased access to mobile technological devices, the availability of support systems and the need for communication paved the way for learning to be available anytime, everywhere. The following are some possible examples – by no means comprehensive – of the rich opportunities that mobile technologies provide to enhance distance learning environments:

- Mobile learning provides more mobility, flexibility and convenience than online learning. Because of the ubiquitous and pervasive nature of mobile devices, it can also be more spontaneous, situated (authentic) and explorative.
- Life-long learning demands 'learn while you earn', which becomes possible through e-learning. Mobile learning takes it further and makes it possible to 'learn while you earn on-the-go'.
- MMS (multimedia messaging system) makes it possible to deliver and receive multimedia content such as audio, images and video sequences.
- m-LMSs (Learning Management Systems for mobile learning) are already starting to emerge.
- Interoperability with e-mail and the Internet is a key factor for new developments.
- Integrating EPSS (Electronic Performance Support Systems) into the mobile environment will take mobile learning even further: mobile learning with on-demand access to information, tools, learning feedback, advice, support, learning materials, etc.

Kukulska-Hulme and Traxler (2005b) summarize the affordances of mobile technologies for learning and teaching as follows: They "[…] open up new opportunities for independent investigations, practical fieldwork, professional updating and on-the-spot access to knowledge. They can also provide the mechanism for improved individual learner support and guidance, and for more efficient course administration and management" (p. 26).

But do mobile technologies lead to a new quality of teaching and learning in terms of interaction and independence, access, flexibility and costs so that it might be appropriate to speak of a new generation of distance education or an 'educational paradigm shift' in the sense of Peters (2004)?

3 Results of survey: What do distance educators think about mobile learning?

In order to address this open question, the authors conducted an international survey amongst distance educators. The questionnaire was distributed by Carl von Ossietzky University of Oldenburg (Center for Distance Education) in cooperation with HfB - Business School of Finance & Management (Frankfurt) in Germany and the University of Pretoria – Department for Education Innovation (South Africa).[4] The following themes were investigated:

- mobile learning and teaching experience of distance educators,
- the development and growth of mobile learning,
- the impact of mobile technologies on teaching and learning,
- mobile learning applications and mobile learning activities,
- mobile learning and access to (higher) education,
- the future development of mobile learning.

The survey was distributed via professional distance education networks like the European Distance Learning and E-Learning Network (EDEN), the South African Institute for Distance Education (SAIDE), and the Canadian Association for Distance Education (CADE). It was also sent to faculty and alumni of the Master of Distance Education programme at the University of Maryland University College (UMUC) in the U.S. Within two months the authors received 88 responses from 27 countries.

[4] The questionnaire resides at: http://www.webropol.com/P.aspx?id=99123&cid=21011649

3.1 Who responded?

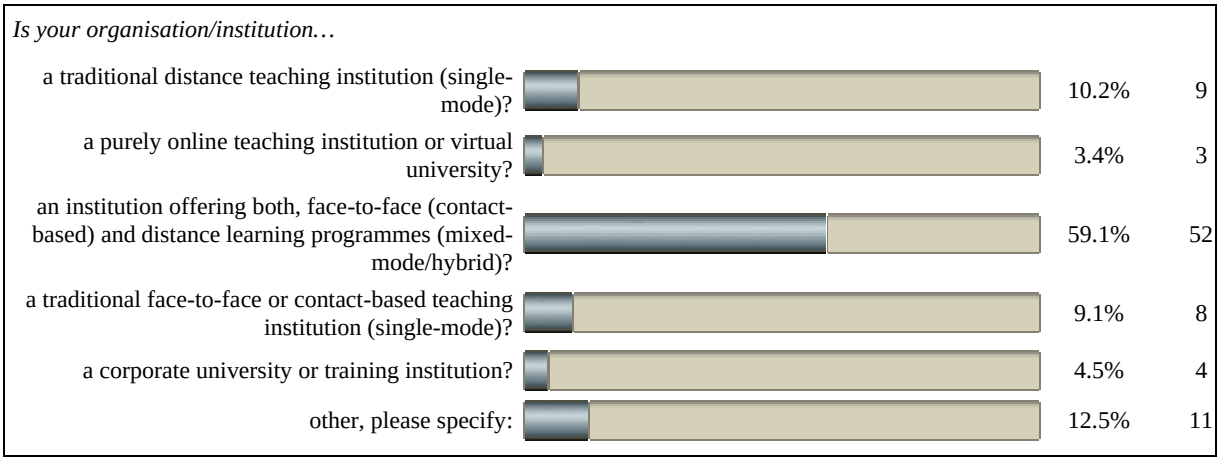
The following table provides information on the countries of origin and the number of respondents.

Table 1: Numbers of respondents from different countries

Country	Responses
Albania	1
Australia	2
Austria	1
Barbados	1
Canada	9
Colombia	2
Cyprus	1
Finland	1
France	1
Georgia	1
Germany	15
Great Britain	8
Hungary	1
Ireland	3

Country	Responses
Israel	1
Lativa	1
Malta	1
Mexico	1
Netherlands	3
Norway	1
Portugal	1
Romania	1
South Africa	15
Sweden	1
Switzerland	1
Turkey	2
USA	12
Total	**88**

The highest percentage of respondents (59,1 %) were from institutions that offer both face-to-face (contact-based) and distance learning programmes (mixed-mode/hybrid). Figure 3 depicts the distribution of respondents amongst defined higher education institution types.

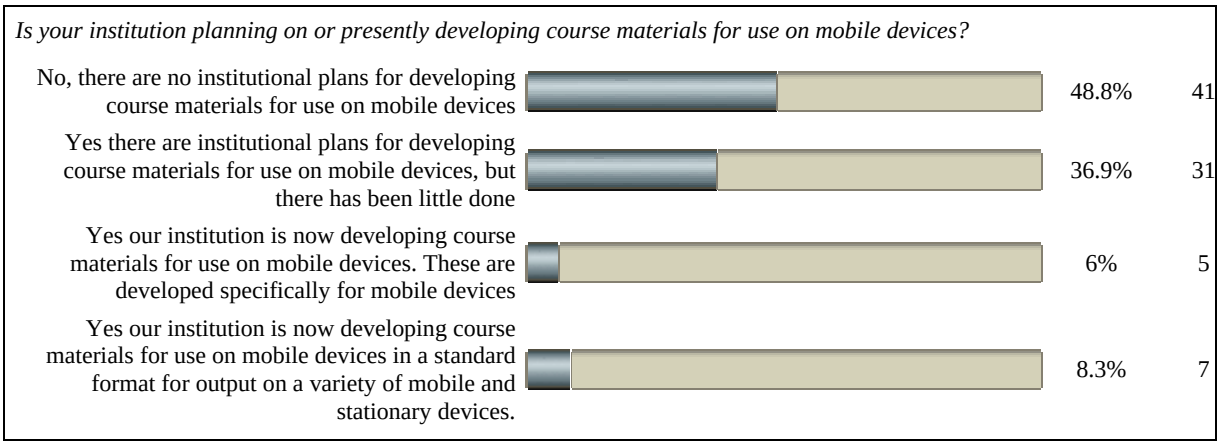


Number of responses: 87

Figure 3: Frequency distribution of responses amongst institution types

The institutions that were referred to as 'other' included a community college, an e-learning service provider, a telecom vendor and a research centre.

Figure 4 represents findings on whether the respondents' institutions have plans for developing course materials for use on mobile devices. Approximately 50% of the participating institutions do not have such plans, while 37% of institutions have envisaged developing course materials but have not as yet done so. Fourteen percent of respondents reported that their institutions indeed have developed such materials for use on mobile devices. Of these more than half reported that they had developed such materials for use on mobile devices in a standard format for output on a variety of mobile and stationary devices.



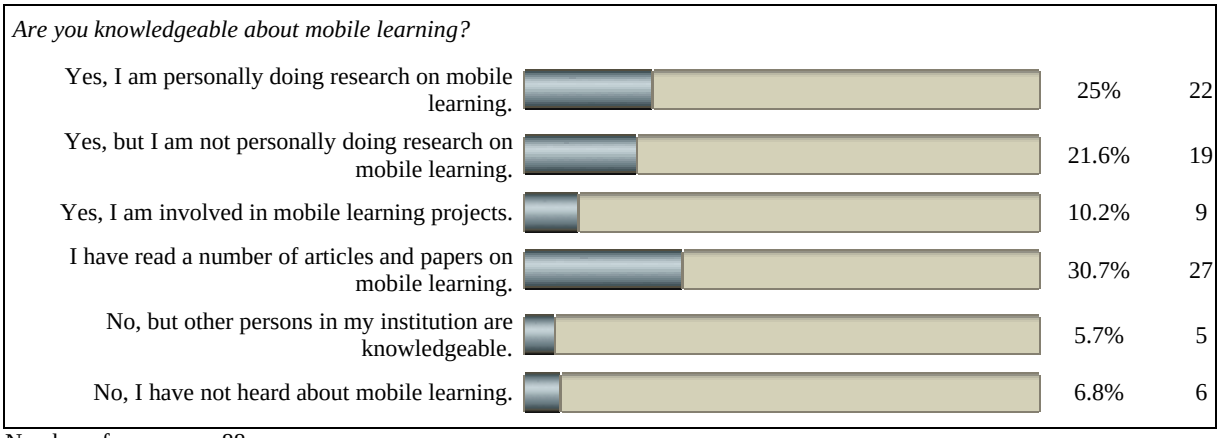
Number of responses: 84

Figure 4: Frequency distribution of responses concerning the development of mobile learning course materials

Of the nine traditional distance teaching institutions being represented in the survey 55% reported having institutional plans for, or are presently developing course materials for use on mobile devices. Respective percentages for the other institutions were 33%, 48% and 75% for the 3 purely online teaching institutions or virtual universities, 52 mixed-mode, and 8 traditional face-to-face or contact-based teaching institutions.

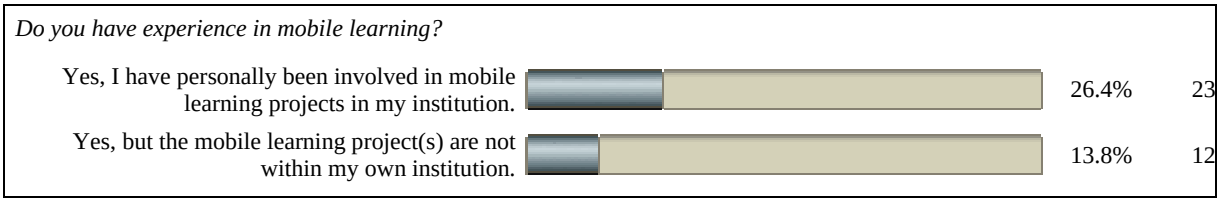
3.2 Mobile learning experience

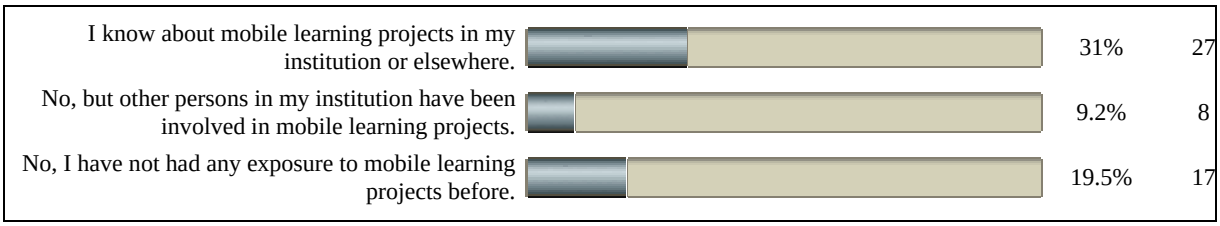
Respondents were requested to report on the extent to which they are knowledgeable about and have experience in mobile learning. These findings are represented in Figures 5 and 6. Approximately 62% of respondents reported being personally involved or have read publications on the subject, while approximately 71% reported being either actively involved, or being informed on mobile learning projects in their own or other institutions.



Number of responses: 88

Figure 5: Frequency distribution of responses with respect to being knowledgeable about mobile learning



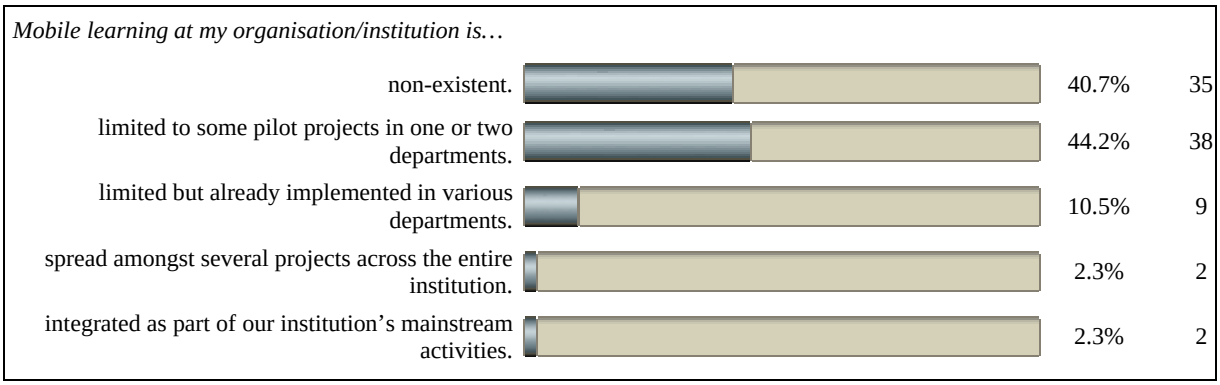


Number of responses: 87

Figure 6: Frequency distribution of responses with respect to having experience in mobile learning

3.3 Development and growth of mobile learning

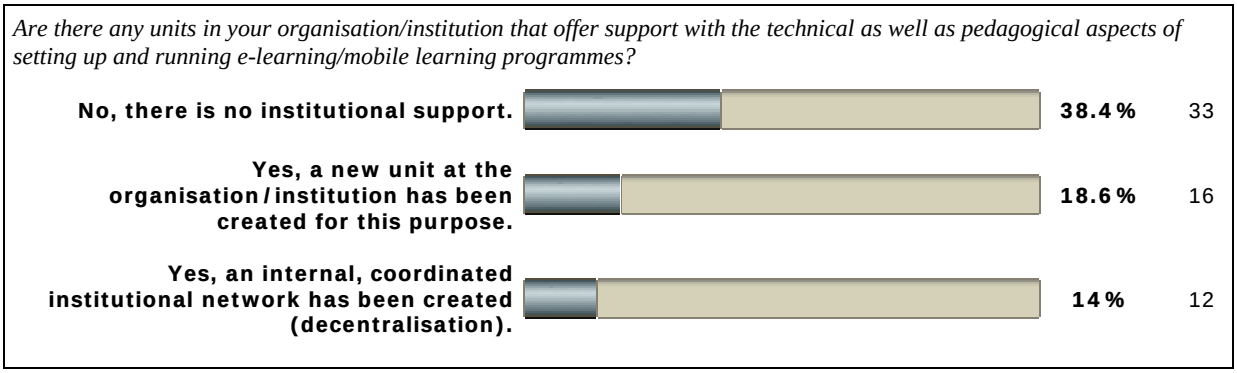
Of the 86 respondents who reported on the implementation of mobile learning within their institution, 41% reported that it does not exist, while only about 5% reported mobile learning to be either spread amongst several projects across the entire institution (2.3%) or integrated as part of their institution's mainstream activities (2.3%). The remainder had instituted mobile learning as pilot projects in one or two departments (44.2%) or had already implemented mobile learning in various departments to a limited extent (10.5%).

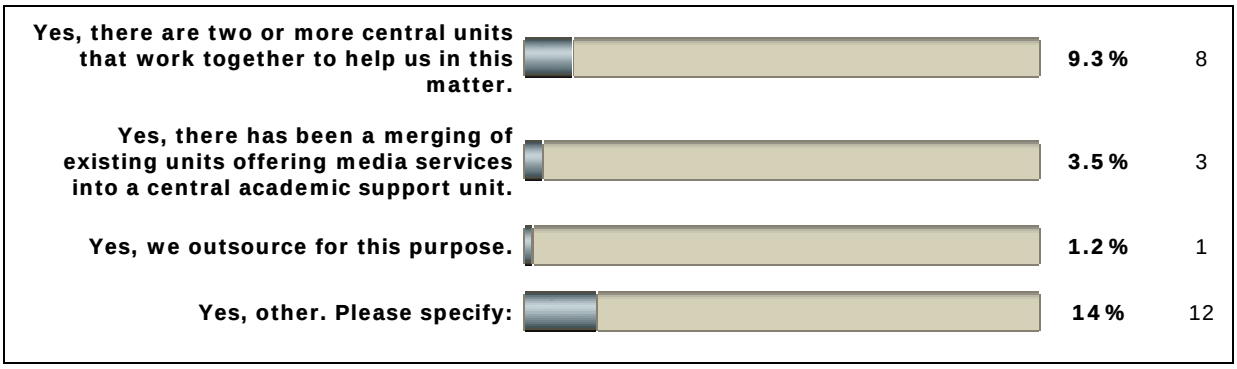


Number of responses: 86

Figure 7: Frequency distribution of responses with respect to the implementation of mobile learning within the organisation/institution

As was to be expected, non-existence or existence in some or other form of mobile learning and being knowledgeable about mobile learning were significantly associated, as was the case for non-existence or existence and having experience in mobile learning (respective Chi-square, p-values: 22.7, $p<0.0001$ and 32.9, $p<0.0001$). A significant association was, however, observed between non-existence or existence in some or other form of mobile learning at an institution and the absence or presence of some or other form of institutional support (Chi-square 9.9, $p=0.002$). This may imply that institutional support is essential for the implementation of mobile learning. Figure 8 depicts a variety of possibilities within an organisation/institution that offer support with the technical as well as pedagogical aspects of setting up and running e-learning/mobile learning programmes.

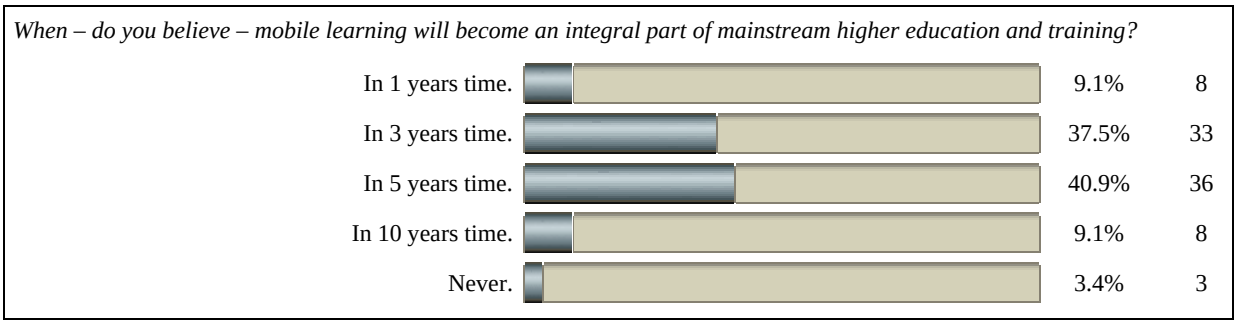




Number of responses: 85

Figure 8: Frequency distribution of responses with respect to technical as well as pedagogical support within an organisation/institution

Surprisingly, 36.4% of respondents stated that there is no support available from the teaching institution to offer e-learning or mobile learning courses, although some respondents mentioned that there are plans to set up a support unit in the near future. Mobile learning was, however, expected by the majority of respondents (78.4%) to become an integral part of mainstream higher education and training within three to five years (Figure 9).



Number of responses: 88

Figure 9: Frequency distribution of responses with respect to expected duration of time during which mobile learning will become an integral part of mainstream higher education and training

The findings depicted in Figure 10 suggest that online and distance teaching institutions are spearheading the development of mobile learning. Sixty seven percent of online teaching and 56 % of distance teaching institutions plan on, or are presently developing learning material for mobile devices, in contrast to only 24 % of traditional contact-based teaching institutions.

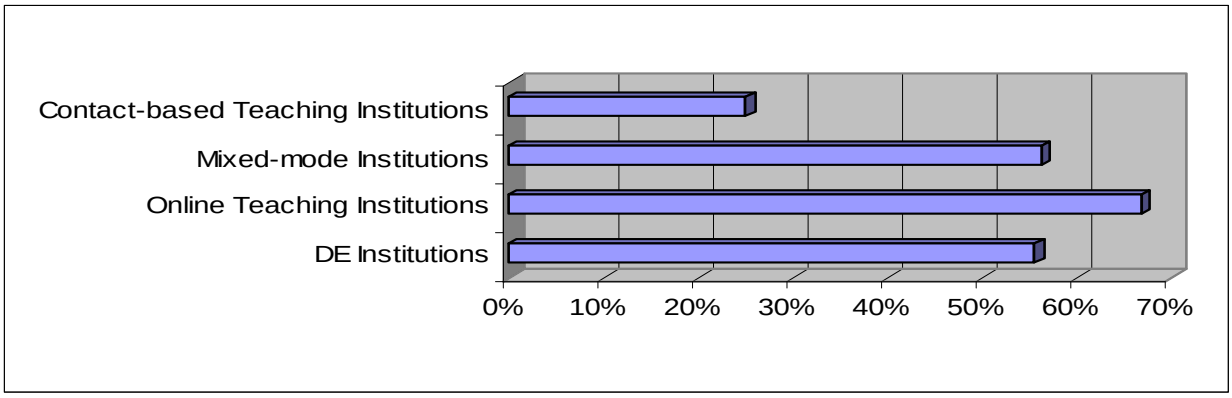
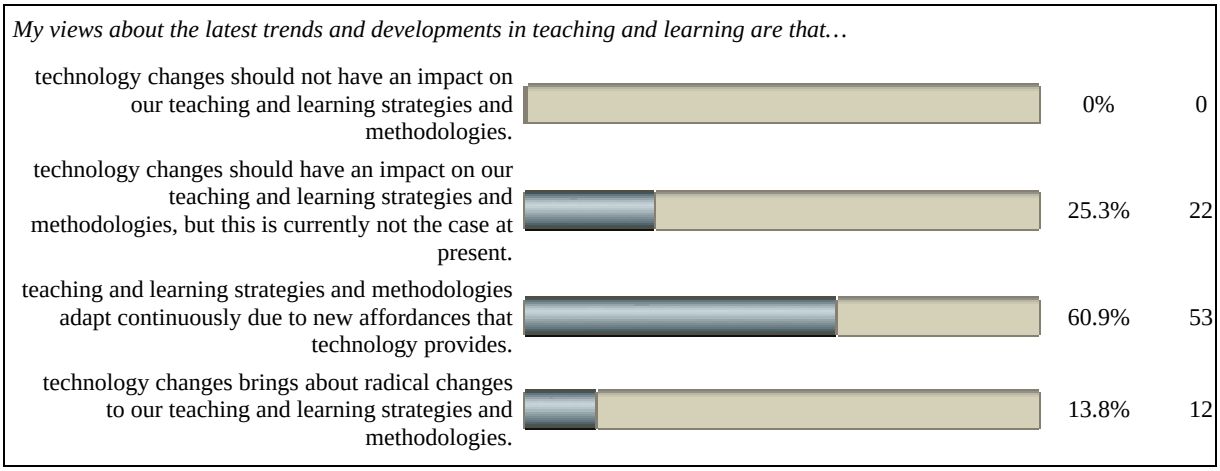


Figure 10: Institutions that plan on, or are presently developing learning material for mobile devices

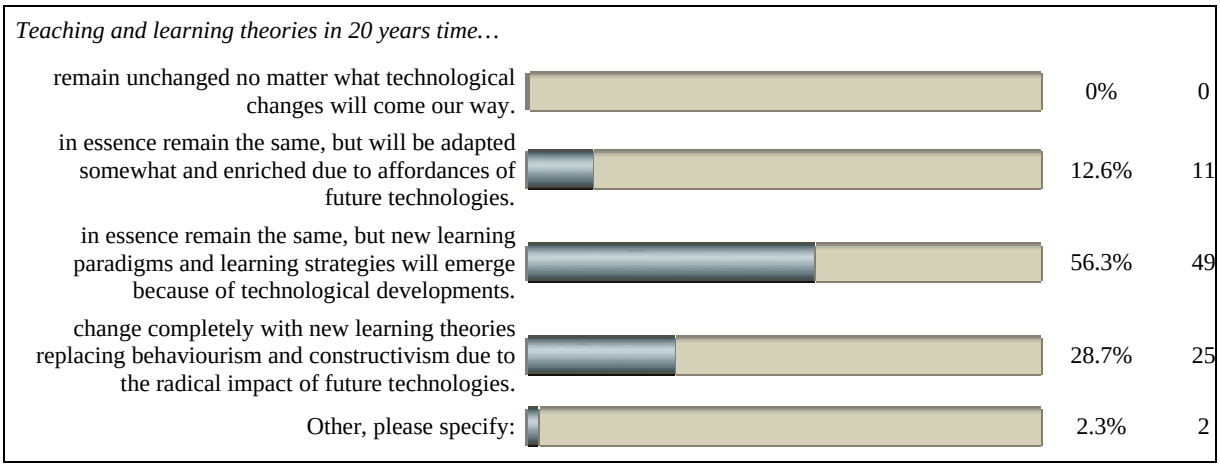
3.4 Impact of mobile technologies on teaching and learning

Figures 11 and 12 depict reflections and expectations concerning changes in teaching and learning practice as well as learning theories. Figure 13 reports on expectations concerning new strategies and methodologies being facilitated by mobile learning. The main findings are that 61% of respondents expected that teaching and learning strategies and methodologies would adapt continuously due to new affordances that technology provides (Figure 11) and 56% expected learning theories to remain the same in essence, but that new learning paradigms and learning strategies would emerge because of technological developments (Figure 12). The majority of respondents (77%) thought that mobile learning would be very helpful in enhancing teaching and learning independent of time and space (Figure 13).



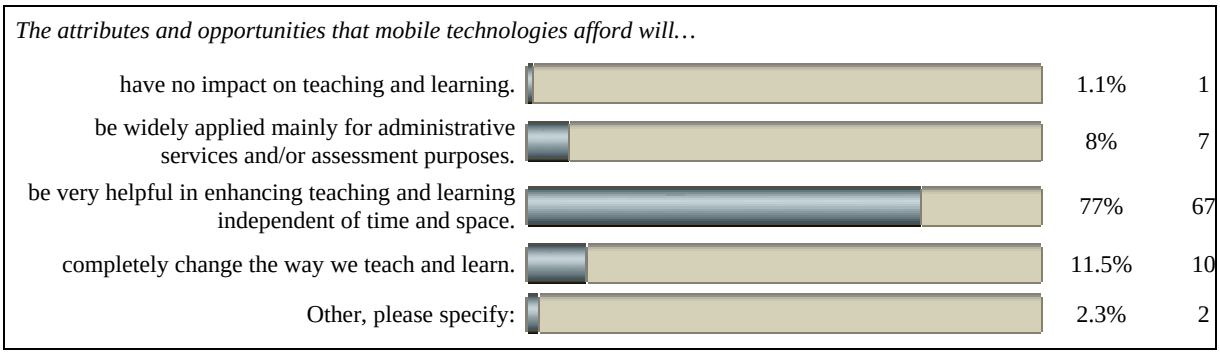
Number of responses: 87

Figure 11: Frequency distribution of responses with respect to views on trends in teaching and learning



Number of responses: 87

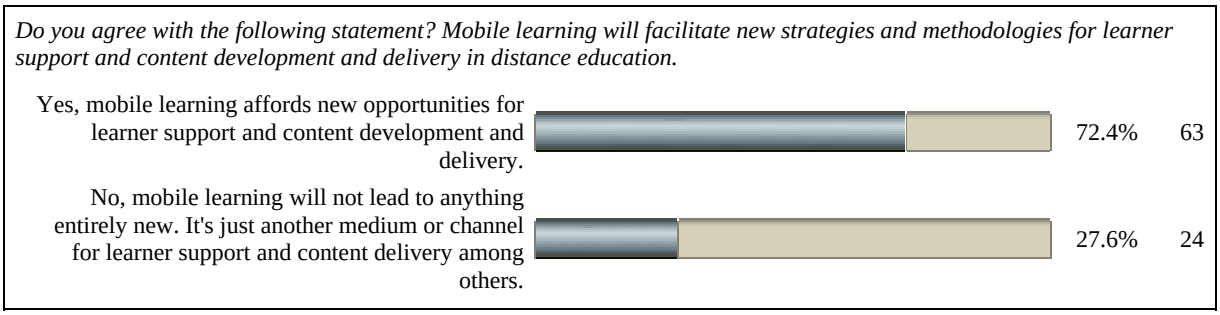
Figure 12: Frequency distribution of responses with respect to anticipated learning theories in 20 years time



Number of responses: 87

Figure 13: Frequency distribution of responses with respect to the expected impact of the attributes and opportunities that mobile technologies afford

One respondent remarked that "mobile devices will make learning even more flexible and spontaneous than 'traditional' e-learning". Most respondents (72%) believed in principle that mobile learning would afford new opportunities for learner support and content development and delivery (Figure 14).



Number of responses: 87

Figure 14: Frequency distribution of responses with respect to new strategies and methodologies being facilitated by mobile learning

Strategies and methodologies that may be afforded by mobile technology were proposed by respondents. These suggestions are grouped and categorized in the following table.

Table 2: Strategies and methodologies as proposed by respondents

Category	**#***	**Typical examples**
Learning activities	19	(Inter)active learning, authentic learning, explorative learning, project orientated learning, situated and informal learning, Qs and As.
Assessment	3	Security for testing and evaluation procedures, assessment to determine students' knowledge a day or two before a lecture/discussion to determine which topics need more attention.
Resources	9	Generation of information, sharing resources, data sourcing, access to information, navigation, m-library.
Interaction	6	More support for collaboration, more support for bottom-up content creation, enhanced social support, consulting peers and experts. Distance Educators will teach again instead of providing teaching material only.
Personalisation and individualisation	12	New strategies might emerge from better knowledge of learner behaviours and study patterns with technology, which were never examined that closely before, just-in-time learning, addressing learner styles or needs, keeping it simple, focus on small 'chunks' of learning, just-in-time support/job aids.

* Number of times suggested by respondents

The relation between anticipated affordances of mobile learning and being knowledgeable about and have experience in mobile learning was evaluated. A positive response on whether mobile learning will facilitate new strategies and methodologies for learner support and content development and

delivery in distance education was reported by 88% of individuals (15/17) who said that they were knowledgeable on mobile learning as they were personally doing research on mobile learning, 61% of individuals (11/18) who reported "Yes, but I am not personally doing research on mobile learning", 100% of individuals (7/7) who reported "Yes, I am involved in mobile learning projects", 57% who had read a number of articles and papers on mobile learning (13/23), 67% who reported "No, but other persons in my institution are knowledgeable" (2/3), and 75% who reported "No, I have not heard about mobile learning" (3/4). Concerning experience in mobile learning and a positive response on whether mobile learning will facilitate new strategies and methodologies for learner support and content development and delivery in distance education, the following percentages were observed for the items tabled:

Table 3: Experience in mobile learning and anticipated affordances of mobile learning

Experience in mobile learning…	Positive response	(n)
Yes, I have personally been involved in mobile learning projects in my institution.	88 %	15/17
Yes, but the mobile learning project(s) are not within my own institution.	67 %	6/9
I know about mobile learning projects in my institution or elsewhere.	54 %	14/26
No, but other persons in my institution have been involved in mobile learning projects.	100 %	6/6
No, I have not had any exposure to mobile learning projects before.	69 %	9/13

From these findings it is thus concluded that the expectations concerning the affordances of mobile learning are based on knowledge and experience of mobile learning.

3.5 Mobile learning applications and mobile learning activities

Respondents were requested to rate the importance of learning 'tools' for students on mobile phones or smartphones (Table 4), the importance of learning activities which are appropriate for mobile devices (Table 5) (with suggestions for additional learning activities), and the importance of applications (software) on mobile devices (Table 6). Respondents were also asked to rate the usefulness of mobile learning 'tools' for students on PDAs or smartphones (Table 7).

Table 4: Rating of importance of learning 'tools' for students on mobile phones or smartphones

	Importance ratings				
	1	**2**	**3**	**4**	**5**
Text messaging (SMS) for communication and interaction. (Number of responses: 86)	27.9% 24	18.6% 16	25.6% 22	18.6% 16	9.3% 8
Voice calls for communication and interaction. (Number of responses: 87)	12.6% 11	27.6% 24	29.9% 26	16.1% 14	13.8% 12
Text messaging to e-mail and vice versa. (Number of responses: 86)	18.6% 16	27.9% 24	19.8% 17	20.9% 18	12.8% 11
Sharing texts, notes and documents. (Number of responses: 86)	14% 12	17.4% 15	20.9% 18	22.1% 19	25.6% 22
Being connected anywhere, anytime. (Number of responses: 86)	55.8% 48	12.8% 11	4.7% 4	8.1% 7	18.6% 16
Totals for rating columns	25.8% 111	20.9% 90	20.2% 87	17.2% 74	16% 69

Rating from 1-5 where 1 is the most important
Total number of ratings: 431

Table 5: Rating of importance of learning activities which are appropriate for mobile devices

	Importance ratings				
	1	**2**	**3**	**4**	**5**
Coursework (accessing and reading learning materials) (Number of responses: 85)	10.6% 9	10.6% 9	22.4% 19	29.4% 25	27.1% 23

Assessment (quizzes, tests, questions-and-answers, etc) (Number of responses: 85)	17.6% 15	16.5% 14	23.5% 20	18.8% 16	23.5% 20
Collaborative learning (interaction with tutor, discussion with other students, group work) (Number of responses: 85)	31.8% 27	22.4% 19	25.9% 22	10.6% 9	9.4% 8
Field work (location-based learning: gathering and sharing on the site information) (Number of responses: 84)	39.3% 33	19% 16	14.3% 12	14.3% 12	13.1% 11
Information retrieval (search in databases and encyclopaedias) (Number of responses: 85)	23.5% 20	21.2% 18	24.7% 21	20% 17	10.6% 9
Totals for rating columns	24.5% 104	17.9% 76	22.2% 94	18.6% 79	16.7% 71

Rating from 1-5 where 1 is the most important
Total number of ratings: 424

The following additional learning activities and applications to be employed in mobile learning might include as suggested by respondents: authentic explorative learning, reflective diaries, Pre-programmed simulations and scenarios for onsite (field) applications, sharing pictures and video, podcasting, tracing and tracking students locations, data collection in applied settings for personal or group projects, daily new vocabulary, exam reminders, mobile gaming and quizzes, location based services (e.g. Semapedia.org) and quick reference systems.

Table 6: Rating of importance of applications (software) on mobile devices

	Importance ratings				
	1	**2**	**3**	**4**	**5**
Mobile Office (Word, Excel, Powerpoint, etc). (Number of responses: 85)	16.5% 14	31.8% 27	20% 17	10.6% 9	21.2% 18
Diary and scheduling. (Number of responses: 77)	28.6% 22	20.8% 16	20.8% 16	22.1% 17	7.8% 6
Audio and video applications. (Number of responses: 84)	22.6% 19	20.2% 17	21.4% 18	19% 16	16.7% 14
Imaging. (Number of responses: 75)	4% 3	29.3% 22	17.3% 13	32% 24	17.3% 13
Additional accessories (notes, calculator, etc.). (Number of responses: 78)	14.1% 11	16.7% 13	26.9% 21	17.9% 14	24.4% 19
Browser for internet connection/online data services. (Number of responses: 85)	37.6% 32	23.5% 20	10.6% 9	16.5% 14	11.8% 10
Totals for rating columns	20.9% 101	23.8% 115	19.4% 94	19.4% 94	16.5% 80

Rating from 1-5 where 1 is the most important
Total number of ratings: 484

Table 7: Rating of usefulness of the mobile learning 'tool' that were perceived as being most useful

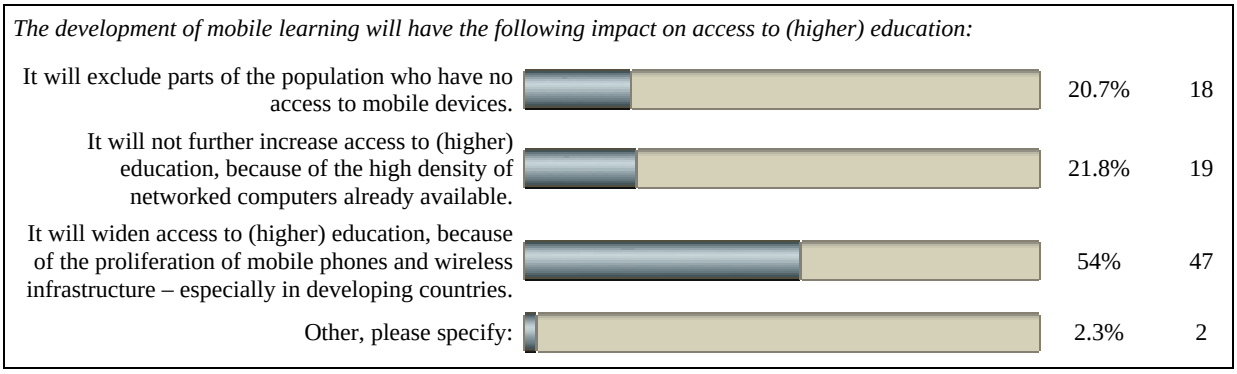
	Importance ratings				
	1	**2**	**3**	**4**	**5**
Sharing texts, notes and documents via bluetooth or wireless connections. (Number of responses: 82)	15.9% 13	25.6% 21	22% 18	22% 18	14.6% 12
Accessing class notes, schedules, documents, websites, etc via wireless connections. (Number of responses: 82)	23.2% 19	26.8% 22	25.6% 21	14.6% 12	9.8% 8
Using the scheduling and diary applications for organising their learning environments. (Number of responses: 81)	14.8% 12	29.6% 24	19.8% 16	16% 13	19.8% 16
Using mobile Office or the like applications for their normal learning activities. (Number of responses: 82)	11% 9	19.5% 16	22% 18	25.6% 21	22% 18

Being connected anywhere, anytime. (Number of responses: 82)	52.4% 43	9.8% 8	9.8% 8	7.3% 6	20.7% 17
Totals for rating columns	23.5% 96	22.2% 91	19.8% 81	17.1% 70	17.4% 71

Rating from 1-5 where 1 is the most important
Total number of ratings: 409

3.6 Mobile learning and access to (higher) education

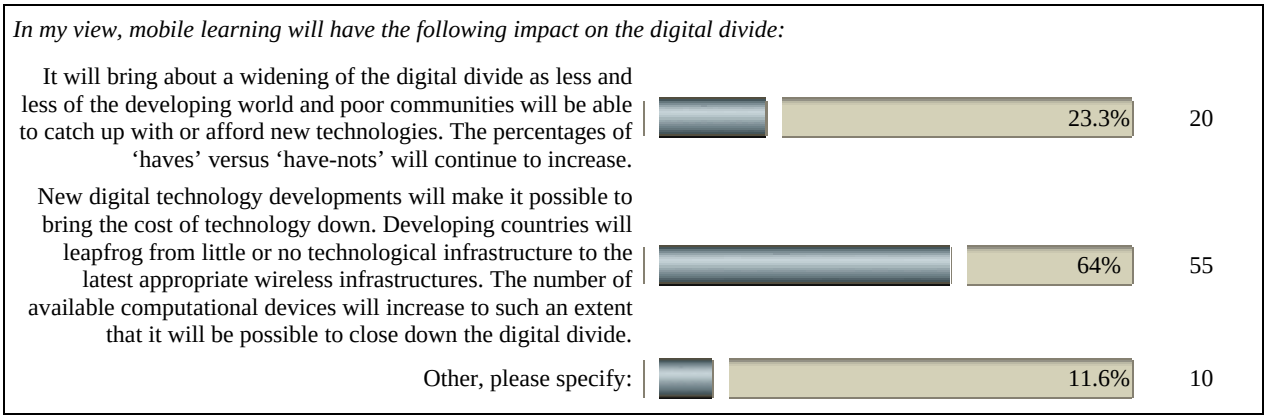
Reponses were elicited on expectations concerning the impact of mobile learning on access to (higher) education. The findings are depicted in Figure 15. The general expectation (54%) was that it would widen access to (higher) education, because of the proliferation of mobile phones and wireless infrastructure – especially in developing countries.



Number of responses: 86

Figure 15: Frequency distribution of responses with respect to expected impact on access to (higher) education

Figure 16 provides information on the anticipated effect of mobile learning on the digital divide. Sixty four percent of respondents suggested that the new digital technology developments will have positive effects concerning access to and costs of wireless technology. Several respondents emphasized that both statements are true to a certain degree: "I believe they complement one another and proceed to stabilize degrees of inequality we are already confronted with. If noticeable (mass), positive changes are to be noticed the time frame in my opinion would be 20 years". Another respondent reminded us that "The cost of technology will go down and access will increase, still, but there will remain parts of the population without access. However, those who previously 'had not' may now 'have', but maybe their technologies will be a little bit older". Only one of 86 respondents did not agree within any of the two statements and stated in a comment that mobile learning would not affect the digital divide at all.

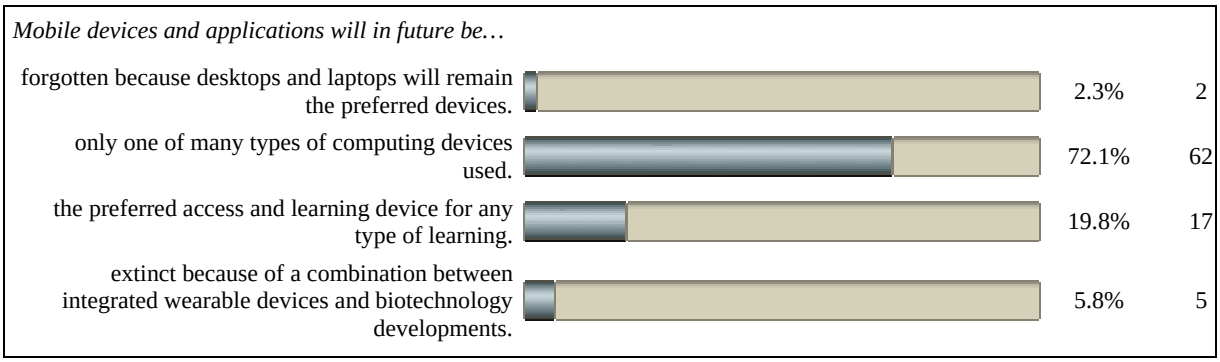


Number of responses: 85

Figure 16: Frequency distribution of responses with respect to the effect of mobile learning on the digital divide

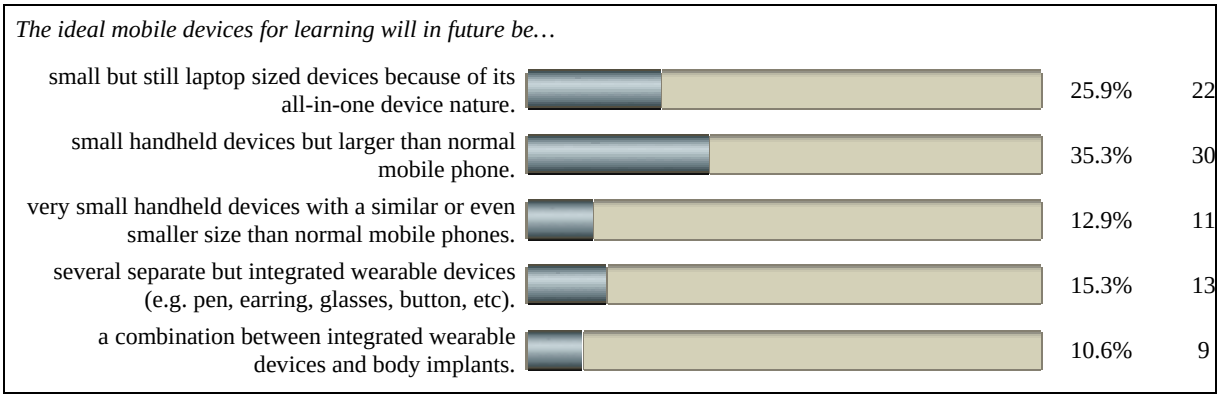
3.7 Future development of mobile learning

Mobile devices and applications are expected to be only one of many types of computing devices used in future, as is evident from 72% of responses depicted in Figure 17 on the significance of mobile devices in the future. Responses concerning the attributes of the ideal mobile devices for learning are depicted in Figure 18.



Number of responses: 86

Figure 17: Frequency distribution of responses with respect to the significance of mobile devices in the future



Number of responses: 85

Figure 18: Frequency distribution of responses with respect to the attributes of mobile devices in future

The following table summarizes agreements on statements concerning the major weaknesses of mobile devices that might hinder the distribution of mobile learning.

Table 8: Rating on statements concerning major weaknesses of mobile devices that might hinder the distribution of mobile learning

Major weaknesses of mobile devices that might hinder the distribution of mobile learning: Do you agree with the following statements (1 = strongly disagree; 5 = strongly agree)

	1	**2**	**3**	**4**	**5**
1. Displays and screens are too small to present complex learning material. (Number of responses: 85)	11.8% 10	5.9% 5	20% 17	28.2% 24	34.1% 29
2. Screen size should not be important as mobile devices should be used for communication and interaction purposes rather than for content distribution. (Number of responses: 84)	14.3% 12	21.4% 18	16.7% 14	32.1% 27	15.5% 13
3. Costs of mobile network services will continue to decrease and should not play an important role. (Number of responses: 85)	4.7% 4	18.8% 16	21.2% 18	36.5% 31	18.8% 16
4. Technological advancements make it possible to have sufficient memory for small images, audio	3.5% 3	4.7% 4	14.1% 12	42.4% 36	35.3% 30

and video clips. (Number of responses: 85)					
5. Device capabilities and mobile network infrastructures are improving to provide sufficient data transmission capacity (e.g. 3G and HSDPA). (Number of responses: 83)	3.6% 3	9.6% 8	15.7% 13	41% 34	30.1% 25
6. Limited battery life of mobile devices is a problem for extensive use. (Number of responses: 85)	8.2% 7	21.2% 18	11.8% 10	29.4% 25	29.4% 25
Totals for rating columns	7.7% 39	13.6% 69	16.6% 84	34.9% 177	27.2% 138

Rating:1 = strongly disagree; 5 = strongly agree
Total number of ratings: 507

4 Conclusions and further perspectives

The aim of this paper was to explore mobile learning as a new field of pedagogical activity, with a view to determining if mobile learning is a new generation of distance education or perhaps even an educational paradigm shift.

a) Integration into the mainstream?

Currently the penetration of mobile learning is low, with only 14% of institutions represented in this study reporting that their institutions indeed have developed course materials for use on mobile devices. The majority of respondents (72.7 %) are from traditional distance teaching institutions, purely online teaching institutions/virtual universities or mixed-mode institutions offering both distance education and face-to-face classes, since the questionnaire was addressed to distance educators via distance education networks. This may have induced a bias in the findings; nonetheless it may be inferred that the application of mobile learning is even much lower in traditional, campus-based higher education and training institutions.

Notwithstanding the low penetration, 55 % of distance teaching institutions and 48% of mixed-mode teaching institutions plan on, or are presently developing learning material for mobile devices. A high percentage of respondents (88%) reported being already personally involved in mobile learning projects or to have read publications on the subject (Figure 5), while approximately 71% reported either being actively involved or being informed on mobile learning projects in their own or other institutions (Figure 6). Furthermore, approximately 78 % of respondents believed that mobile learning will become an integral part of mainstream higher education and training within 3-5 years (Figure 9). Sixty four percent of respondents suggested that wireless technology developments will have positive effects on closing down the digital divide.

Therefore, it cannot be claimed that mobile learning is part of mainstream education and training yet, but it has potential and there is a demand to move from pilot project status to the mainstream. Organizational student and faculty support is of the utmost importance in order to foster the education innovation process (cf. section 3.3).

b) A new generation of distance education?

Properly designed mobile learning can be spontaneous, ubiquitous and pervasive. It affords various opportunities for teaching and learning, especially interaction (two-way communication), flexibility, and maximal access, even in contrast to 'traditional' e-learning. Fifty four percent of respondents suggested that mobile learning will widen access to (higher) education, because of the proliferation of mobile phones and wireless infrastructure - especially in developing countries.

The role that communication and interaction play in the learning process is critical in contemporary learning paradigms. Mobile technologies seem to provide opportunities for optimizing interaction and communication between lecturers and learners, among learners and among members of communities of practice. Mobile learning enhances collaborative, co-operative and active learning.

Based on the criteria of interaction, independence, access and flexibility we can conclude that mobile learning has the potential to become a new generation of distance education in the sense of Garrison (1985) - provided that mobile learning becomes integrated into the mainstream provision of education and training.

c) An educational paradigm shift?

The expectations expressed by the respondents concerning the impact of mobile learning on teaching and learning strategies and methodologies, as well as on learning theories (Figures 11 and 12), may signify a change in thinking, in that technology is expected to induce changes in the former, while learning theories are expected to remain the same in essence. Only 29% of respondents expect learning theories to change completely, with new learning theories replacing behaviourism and constructivism due to the radical impact of future technologies (Figure 12). The majority of respondents (72 %) agreed that mobile learning affords new opportunities for learner support, content development and delivery. However, only 12 % of polled distance education experts believed that mobile technologies will "completely change the way we teach and learn", while the majority of respondents (77%) thought that mobile learning would be very helpful in enhancing teaching and learning independent of time and space. An array of new strategies and methodologies were proposed by respondents.

Mobile learning affords new channels of support, among others: "The emphasis should be on 'enhancing' learning opportunities, rather than 'replacing' other forms of teaching and learning".

In terms of the definition of educational paradigm shifts by Peters (2004) and the data collected, we cannot confirm that we face an educational paradigm shift with the emergence of mobile learning. Learning with mobile devices appears to be a further development of 'traditional' e-learning.

d) Future development of mobile learning

The final frontier to cross to convince us that mobile learning is the new and next generation of distance education, is for mobile learning to be incorporated into mainstream education.

Beside the technical and economic challenges that were mentioned, it is the support of the faculty, teachers and trainers that is critical for the success of education innovation (Zawacki-Richter, 2005). With regard to higher education, Bates (2000) emphasizes that "presidents may dream visions, and vice presidents may design plans, and deans and department heads may try to implement them, but without the support of faculty members nothing will change" (p. 95). Acceptance of new media, not only by pioneers and early adoptors, but also by the majority of users (cf. Rogers, 1995) is the prerequisite for education innovation.

Keegan (2005) claims that mobile learning is not perceived to be a satisfactory revenue stream by the telecommunications operators, which is the major barrier to moving mobile learning from single project status to the mainstream. He proposes five solutions to this problem:

> "Firstly, there are thousands of universities and further and higher education colleges all over the world. If they can all be convinced to accept mobile learning as their normal means of communication with all their students on changes of timetable, submission deadlines, enrolment procedures and other administrative necessities, a massive mobile learning revenue stream will already be set up.
>
> Secondly, the production of a mobile learning development kit for distribution to universities and colleges to enable them to introduce mobile learning will set up another revenue stream.
>
> Thirdly, the production of course guides, course summaries, examination reminders, helps with difficult parts of a course, will set up another revenue stream.
>
> Fourthly, the production of full course modules for PDAs, handhelds, palmtops, and also for smartphones and eventually for mobile phones, will set up another revenue stream.
>
> Finally, the literature of the field needs to be developed, books on mobile learning need to be written, conferences like this one need to be organised" (p. 16).

It was shown in this study that mobile technologies afford new opportunities for teaching and learning which might convince innovative faculty, teachers and trainers to consider adopting mobile learning.

Perhaps the hard work for acceptance done in the history of distance education and e-learning will also have a positive impact on the development of mobile learning. It now has to prove the value it can add to the teaching and learning process on a large scale.

Only when such evidence is exhibited, can we share the optimistic estimation of Wagner (2005): "Whether we like it or not, whether we are ready for it or not, mobile learning represents the next step in a long tradition of technology mediated learning. It will feature new strategies, practices, tools, applications, and resources to realize the promise of ubiquitous, pervasive, personal, and connected learning. It responds to the on-demand learning interests of connected citizens in an information-centric world" (p. 44).

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