6 Mobile Learning and Higher Education

Claudia de Witt & Christina Gloerfeld

Abstract
Digital media changed teaching and learning and are continuing to do so. The spread of mobile devices and mobile internet opened up further potential and pushed mobile learning into the universities. New technologies like cloud computing, learning analytics and augmented reality promise new mobile learning solutions. With the rise of apps, access to learning content and information is always and everywhere at students´ fingertips. This ubiquitous availability leads to a variety of learning scenarios – seamless, contextualized or personal learning. They can be grouped into four categories according to their dependence of place and time; learning independent of place and time, situated and authentic at concrete learning places, application at presence teaching, usage in distance learning respectively virtual presence.
In this article, the current situation of mobile learning in higher education is discussed and mobile learning offers of nine top universities are compared exemplary. There are two main findings: first, universities lack behind developing scalable didactical concepts for mobile learning, but second, they use to transfer e-learning solutions or prolong face-to-face learning scenarios to mobile devices. Hence an entire alteration did not occur so far. However mobile learning will continue to intrude everyday life at universities and keep transforming the way we teach and learn.

Keywords: Mobile learning, Higher education, Mobile technologies, Scenario framework

6.1 Introduction

Digitalisation of university teaching changes the traditional image of universities and creates a need to reflect about future scientific education. The process of transformation affects the development of universities as much as university teaching. Digital media encourages personalisation of learning and digital forms of cooperation and communication (see Hochschulforum Digitalisierung, 2016).

The question has long ceased whether mobile learning for studying makes sense; technology based learning forms enable didactic-methodical designs, regarding heterogeneous learning needs, different learning biographies and diverse interests of media use (see Herber et al., 2011). Learning with mobile devices and mobile applications offers significantly different and varying teaching and learning formats than before. Teaching and learning applications for smartphones and tablets offer various possibilities of multimedia interaction and communication. Cloud solutions and concepts of BYOD (bring your own device) enable new forms of generating knowledge and using media.

6.2 Range of technological Solutions

Preconditions of mobile learning are mobile internet and mobile devices, which enable the user to display, store and distribute information as well as to interact with others. It was only in 1999 when mobile internet reached Germany at CeBIT, where a transmitting technology with 9,6kb/sec – WAP (Wireless Application Protocol) – was introduced (Diehl-López, n.d.). Since then transmission speeded up rapidly. Today LTE reaches up to 300 mbit/sec.

D. Kergel et al. (Hrsg.), *The Digital Turn in Higher Education*,
https://doi.org/10.1007/978-3-658-19925-8_6

Looking at the hardware, the first mobile phone that could be referenced to as a smartphone, was IBM's Simon Personal Communicator in 1994. Simon had a touchscreen, email capability and could also send faxes. However, it did not have a web browser.[5] With a battery life of one hour, a high price and some technical shortcomings in handling, Simon was cut off after half a year. Instead, Nokia, BlackBerry and Palm led the development of smartphones at the end of the 20th early 21st century.[6] When Apple entered the market with the iPhone in 2007 and with the iPad in 2010, a new era of mobile devices evolved and catalyzed distribution as well as usage of mobile data. The number of smartphone users in Germany rapidly increased from 6.31 million in 2009 to 49 million in 2016 (comScore, n.d.). Peaking in 2010, growth occurred at 66% from 8.43 to 14.03 million users. At the same time the amount of data transmitted via mobile more than doubled from 11.47 million gigabyte to 65.41 million gigabyte. In 2015 data traffic reached 591 million gigabyte in Germany (Bundesnetzagentur, n.d.).

There is no doubt that mobile devices and internet are part of our daily lives. Communication and information are at our fingertips wherever and whenever we want. They started to change the way we interact, teach and learn (Czerwionka, Klebl & Schrader, 2010; O'Connor, 2012).

The trend to learn independently of time and space by using mobile technologies slowly reaches universities. In the beginning universities started to offer their learning content online as a form of E-Learning. As the distribution of mobile devices and the improvement of communication infrastructure progressed, universities developed mobile applications to administrate and organise study programs by so called 'Campus Apps' (Davie & Heß, 2012). To initiate virtual interaction between students and teachers, wikis, message boards and newsgroups were created (Kleinmann, Özkilic & Göcks, 2008; Kerres & Voß, 2003). The delivery of mobile learning content was catalyzed by 'iTunes U'. It gave teachers a platform to record their lectures and offer them for free. Furthermore, single departments or faculties developed apps to distribute learning content of their lectures. They offered the possibility to generate content, to stimulate interaction or to provide a full master degree program. Even though full study programs, mobile courses and stand-alone mobile learning solutions are still an exception, they show the broad scope of mobile learning (Wegener, Bitzer, Oeste & Leimeister, 2011).

There are different possibilities to use upcoming technologies like the mobile internet for learning. Mainly there are four different kinds of tasks mobile learning can accomplish: Mobile learning as a stand-alone learning offer; replacing previous learning solutions; expanding the regular offer with additional content and/or features; containing exactly the same offer as the regular scenario or even less.

In 2015 Maren Lübcke identified middle- and short term technological trends in higher education in the course of a meta-analysis of trend studies, scientific publications and weets (Lübcke, 2016). Mobile devices and mobile learning are seen as a short-term trend. The prognosis is that mobile learning will lead to combined informal and formal learning, creating a sense of mobile seamless learning. Furthermore, Lübcke predicts a stronger focus on collaborative mobile learning (Lübcke, 2016). She identified six important technologies for

[5] See: http://time.com/3137005/first-smartphone-ibm-simon/. Last accessed: 27 March 2017

[6] See: http://www.chip.de/bildergalerie/Die-Geschichte-der-Smartphones-Galerie_58060219.html: Last accessed: 23 May 2017.

mobile learning: Cloud computing, adaptive systems, virtual reality, learning analytics, mobile paperless assessments and gamification (ibidem.).

Cloud computing offers the possibility to use applications or services that are centrally stored in a so called cloud – on a cloud platform – in the internet. It is defined as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell & Grance, 2011, p. 2). Thus cloud services offer flexible and easy access to programs and services without the need to buy and install software, which might only be needed for a short period of time or on a rare basis. To put it in a nutshell, it saves storage capacity and money. The idea with cloud computing is that it is scalable in two ways. It can be scaled up or scaled out in size, meaning bigger or more computing power can be used. Also, it is possible to use resources independent of their location (Bräuninger, Haucap, Stepping & Stühmeier, 2012).

Looking at mobile learning the advantages of easy and ubiquitous access to resources is obvious.[7] Bräuninger et al. (2012) named five main components of cloud computing: Resource pooling, rapid elasticity, on demand self-service, broad network access and measured service (Bräuninger et al., 2012). Especially in Germany, given the strict laws on privacy, data security and data protection, the question in which geographical region the data of a cloud is stored might suppose a problem, because a different jurisdiction may apply.

With the growing use of the internet, communication means and digital learning content, the amount of tracking data that documents these activities increases. To make use of this data, technologies are needed to record, display and analyse it. Furthermore, concepts and skills are needed to correctly apply and interpret it. *Learning Analytics* is defined as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" (1st International Conference on Learning Analytics & Knowledge 2011. LAK'11., 2010, p. 4). For mobile learning Davis and Aljohani (2012) break it down to two activities, which are to be tracked. These are the "interaction between learner and available learning materials; this is called Explicit Learner-to-Learning-Materials-Interaction" and "the interaction among learners, this is called here Explicit Learner-to-Learner-Interaction" (Aljohani & Davis, 2012, para. 14).

With tracked data and learning analytics tools a vast variety of possibilities to support the learner evolved. Whether it is for the teacher to be able to offer adequate support when it is needed or for the learner to self-assess his level of learning and/or give automated feedback together with suggestions what to learn next.

Adaptive learning systems use these data to find the best fitting offer for the learner. Paramythis and Loidl-Reisinger (2004) define an adaptive learning environment as adaptive, "if it is capable of: Monitoring the activities of its users; interpreting these on the basis of domain-specific models; inferring user requirements and preferences out of the interpreted activities, appropriately representing these in associated models; and, finally, acting upon the available knowledge about its users and the subject matter at hand, to dynamically facilitate

[7] More details about cloud computing in mobile learning can be found in Jansen, Bollen & Hoppe, 2017.

the learning process" (Paramythis & Loidl-Reisinger, 2004, p. 182). According to mobile learning the term activity should be complemented with different context information like geographical location, transmitted data from nearby objects (e.g. artifacts in a museum, smart home devices, mobile payment, etc.), subjects (other learners or teachers) and the learner himself (e.g. data from activity tracker). Adaptive systems may lead to individual, personalized but directed learning (by an automated system) in contrast to self-determined learning (Goertz, 2014). However, adaptive systems may be a scaffold to guide learners to become self-determined. The crucial point is whether or not the power what, when and how to learn remains in the hands of the learner. Thus, suggestions and recommendations by the system should be optional and the reasons why they are proposed should be made transparent to the learner.

Virtual reality is an old technology dated back to the beginning of the 20th century when a patent for a head-based periscope display was granted (Sherman & Craig, 2003). It is an artificial, technologically constructed world, in which the user is completely immersed (Azuma, 1997). Furthermore Sherman and Craig add that the user gets sensory feedback and, that the environment is interactive (Sherman & Craig, 2003).

> **virtual reality** a medium composed of interactive computer simulations that sense the participant's position and actions and replace or augment the feed- back to one or more senses, giving the feeling of being mentally immersed or present in the simulation (a virtual world). (Sherman & Craig, 2003, p. 13, emphasis in original)

Common tools to experience virtual reality are virtual reality glasses or combined with other so called wearables like gloves or suits. With the help of virtual reality, learning scenarios, knowledge and skills can be trained in secure environments. For example, learners can practice to repair expansive machines in virtual reality before working on real machines and likewise medicine students can operate on virtual patients first (a good overview can be found in Metzger, Jannaber, Berkemeier & Thomas, 2017).

A*ugmented reality* is a special variation of virtual reality and very closely related to it (Azuma, 1997).

> **augmented reality** a type of virtual reality in which synthetic stimuli are registered with and superimposed on real-world objects; often used to make information otherwise imperceptible to human senses perceptible. (Sherman & Craig, 2003, p. 18, emphasis in original)

Hence, while in a virtual reality environment the world the user acts in is an artificial one, in augmented reality the physical world is visible and just enhanced with virtual objects as an additional layer, not as a substitution. Augmented reality also bears high potential to support teaching and learning, because it can be perfectly integrated into real life or working processes (Azuma, 1997). Necessary information or guidance can be provided without interrupting activities or additional effort. In addition, using AR or VR is fun and motivating because it is very playful and also used for gaming.

Deterding, Dixon, Khaled and Nacke (2011) define *gamification* "as *the use of game design elements in non-game contexts"* (Deterding, Dixon, Khaled, & Nacke, 2011, p. 9, emphasis in original) for example in learning environments. The aim is to increase motivation, engagement and activate learners (Butgereit, 2016; Deterding et al., 2011). In contrast to that, a game, designed to not just entertain the user, is called serious game (Deterding et al., 2011). Examples for game elements in mobile learning are badges, scores, high-scores, levels, challenges or competitions (Butgereit, 2016). Butgereit identifies different game mechanics,

with which she achieved improvement in a course with PhD-students; challenges, quests, points, leaderboards, badges, levelling, onboarding and engagement loops (Butgereit, 2016). A very easy implementation in mobile learning can be achieved with direct response systems, because nearly every student has a smartphone with internet connection and the applications are web-based, easy to use and free of charge. Here participants can be grouped in teams and a competition about the correct answers can start (e.g. 'Poll Everywhere').[8] Badges like Mozilla Open Badges are a kind of award or reward a learner receives to honor his or her achievements. At the same time it can visualize skills or knowledge "surfacing the less-obvious learning that is often hidden due to the focus on grades and transcripts" (Glover & Latif, 2013, p. 1398).

This leads to another important technology to assess the outcome of students – e-assessment or *mobile paperless assessments*. "E-assessment involves the use of digital devices to assist in the construction, delivery, storage or reporting of student assessment tasks, responses, grades or feedback." (Crisp et al., 2011, p. 5) Crisp et al. differentiate between three forms of assessment based on the moment when it takes place. Diagnostic assessments are used before the actual learning process to get to know the starting position of a student. During learning formative assessments document students' performances and reveal lacks of knowledge or students lagging behind. At the end of the learning process summative assessments grade learning outcome or success (Crisp, 2007). A fourth type added later on is called integrative assessment. These are "designed to promote and measure student self-regulation" (Crisp et al., 2011, p. 6). E-Assessments bear two main advantages; they are very efficient and take workload off the teachers (Handke & Schäfer, 2012). They are good tools to support self-guided learning, because they give immediate feedback about the current performance of the student. The most common e-assessments in higher education are closed formats, which are limited to measure declarative knowledge instead of cognitive skills (Cano, 2017). But different skills are needed to become employable in a century, which is mainly driven by digital technology. Crisp et al. (2011) cites seven 21st century skills identified by Mioduser, Nachmias, and Forkosh-Baruch in 2008; multimodal information processing, navigating the infospace, interpersonal communication, visual literacy, hyperacy, personal information management literacy and coping with complexity.

"E-assessment can offer new opportunities to assess these 21st century skills through the design of tasks that require Web 2.0 creative activities; interactive tasks that include branching and decision points such as role plays and scenario based activities; and through the use of global communication tools." (Crisp et al., 2011, p. 12)

Obviously mobile devices and mobile technology can very well support these tasks.

6.3 Range of didactic solutions: Classification of Apps/mobile applications by reference to Bloom's Taxonomy

In the context of teaching, learning and researching at universities there is a multitude of systematics and taxonomies to grade teaching and learning applications. Kathy Schrock (2017), for example, undertakes a classification of apps corresponding to the 6-stepped taxonomy of learning targets of Benjamin Bloom (Figure 6.1).

[8] See: URL: https://www.polleverywhere.com/features/ segmentation. Last accessed: 04 February 2017.

Mobile applications for studying or for preparation of classes or courses can be distinguished between independent of content or dependent of content. Apps **independent of content** are little instruments of work respectively service programs. They include a wide range of functions like searching for information or management of appointments or notices (i.e. with Evernote); communication across Microblogging, Social Media (i.e. Whatsapp or iMessage); showing, editing and managing documents (i.e. with GoodReader, FileApp or AnnotaBitePDF).

There are also apps for storing data or media in cloud systems (i.e. iCloud or Dropbox), scanning documents with photo-cameras (i.e. CamScanner) or for video documentations with cameras or augmented reality (i.e. Layer) or voice recordings to test ones own wordings.

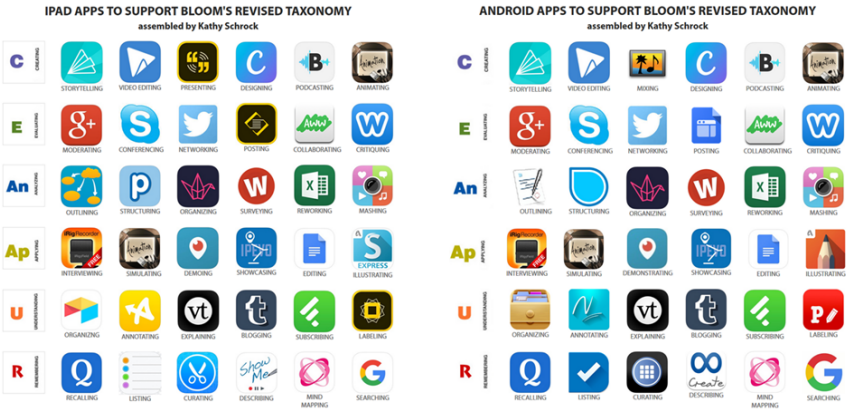

Figure 6.1: Table of classification for Apps with Bloom's arrangement of knowledge, understanding, application, analysis, synthesis and evaluation (Schrock, 2017).

Apps **dependent of content** offer compact, text-based and/or audio-visual learning contents. These can be information units (news, for example), closed learning texts, contents from learning platforms (i.e. Moodle or communication panels), flashcards or vocabulary trainers. Databases of knowledge, lexica, glossary, dictionaries and tests of knowledge also matter. Didactically edited apps for certain subject areas, which offer tasks, solutions and interfaces of communication, are named learning apps. They are designed for learning in little units, short steps and short time periods. This so-called "micro learning" can be understood as a process of short learning activities which are especially conducive if questions are asked, answers framed, opposite positions exchanged or betterments undertaken. Controlling a learning effort can take place via immediate feedback and direct evaluation.

Besides independent and dependent of content, applications can be further classified as learning and organizing.

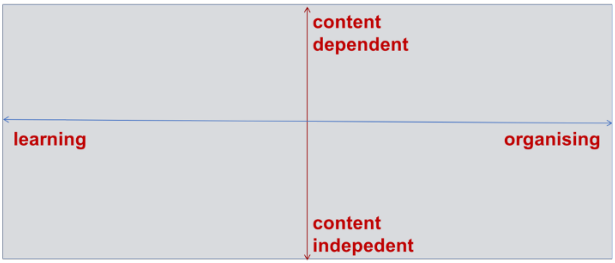

Figure 6.2: Classification of Apps for studies in independent and dependent of content (own Figure).

Thus we distinguish between apps that

1. are able to ease or simplify studies (little or nothing to do with learning) – Organization of learning;
2. organise ideas for oneself, to share with others (i.e. via Dropbox or Evernote), or to use for joint work over texts to collaborate and/or reflect – material elaboration;
3. are suitable for an immediate use during a course like mobile flashcards or direct response apps (i.e. immediate interaction between teacher and learner) – Supporting the process of learning;
4. offer concrete and fixed learning content, a base of knowledge like Wikipedia, a quick test or a context-sensitive tasks – acquisition of information and dealing with information.

Such apps support the use of knowledge and learning contents. They involve the students and activate them to produce contents themselves or to organise learning contents. Mobile learning is designed for three essential activities:

- Research and use of content;
- Production of self-contents and sharing with others;
- Founding of networks and active participation in online-communities.

Accordingly, the essential functions of digital media are the presentation of contents, the visualization of complex facts, the usage as a tool, the preparation and storage of teaching/learning material, communication and collaboration between students and teachers as well as between students themselves.

6.5 Scenarios of Mobile Learning in the Context of Universities

Looking at the development of innovative mobile learning applications, didactic needs rather than technological opportunities are the main driver.

The frame for the design of didactic scenarios for mobile learning depicts factors like targets, target groups, learning contents and learning materials, learning context, teaching and learning organisation, communication and cooperation as well as learning support. These factors are already relevant at the conception of e-learning activities. Specific factors for mobile learning arise by elaborating the aforementioned factors considering other aspects like: the ubiquitous availability of information and communication; learning at any time and

place; support of contextualized and seamless learning; ease of personalised learning; easy conjunction of formal and informal learning, which makes direct feedback and evaluation possible.

According to Arnold, Thillosen and Zimmer (2015), learning scenarios generally describe the pedagogic circumstances respectively the organisation of virtual teaching and learning . The term scenario has a certain character of example or blueprint for a situation of teaching-learning that has to be conducted. With the term scenario the design of teaching-learning processes in or through a teaching-learning surrounding is signified. E-learning scenarios are the result of a technology supported design of teaching-learning situations. To classify the essential scenarios of mobile learning systematics, the two context-factors time and place shall be introduced. Because a didactic scenario after Baumgartner (2006) is defined as "a script for staging a certain arrangement of learning and composes the necessary needs – actions at the (learning-) time respectively equipment at the (virtual) room for the implementation" (Baumgartner, 2006, p. 239).

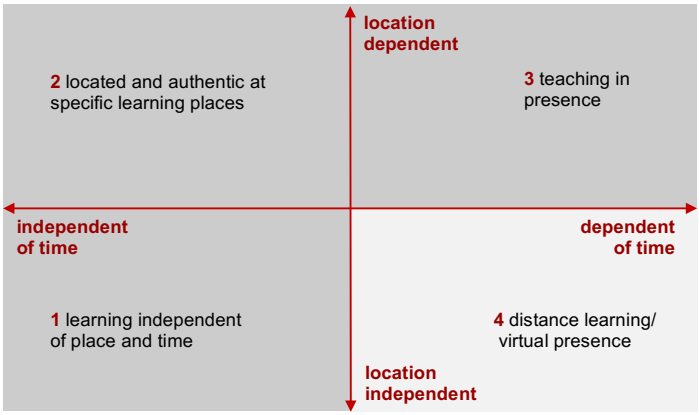

Figure 6.3: Scenarios for mobile learning in dependence to place and time (own Figure).

With the possible different combinations, the following four scenarios derive:

1. Learning independent of place and independent of time;
2. Learning independent of time, but dependent of place: located and authentic at specific learning places;
3. Learning dependent of place and independent of time: teaching in presence;
4. Learning dependent of time, but independent of place: distance learning respectively virtual presence.

6.5.1 Learning independent of Place and Time

Mobile learning is conducted without changing the current location and situation somebody is in. Smartphones and tablets are used in idle or waiting times. In every situation information, knowledge or tools are available. Everybody can access learning materials in audio-, video- or text-formats and micro-content. The learning management systems, which were originally only usable at desktop computers, are meanwhile usable via smartphones or tablets due to

the responsive designs of learning management systems like the Moodle learning environment at the FernUniversität in Hagen. These learning environments are increasingly integrated in mobile personal learning environments (PLEs). Moreover, commercial or learning apps produced by teachers are available. Here, students are able to deepen and extend their knowledge self-determined during phases of self-learning – not only for exams.

6.5.2 Located and authentic at specific Learning Places

In this scenario place is relevant but time is not. Located learning on site means, that knowledge can be acquired in a direct context and classified in the learning coherence, for example at historic sites or excursions. Located and authentic learning supports the ability to explore one's own context and experiment. It also supports the separation of learning processes within a classroom-setting and the initiation of learning in new significant settings outside. Within this learning in a physic context is also meant: Access to knowledge is given contextually to its area of application or when being of meaning.

Mobile technologies offer many opportunities of context-dependent grasp to information, like augmented reality or locations-based services. While learning at a bus stop happens in an irrelevant context, augmented-reality-applications provide relevant learning contents or information at the places the learner is located. Applications of augmented reality has big potential to enable contextual learning experiences as well as *accidentally* researching and exploring pieces of information, which correspond with each other in the real world. Augmented Reality stands for blending, respectively enrichment of virtual data – information and even real action – with something we see in the real world, either via app or AR-glasses. Mechanics already use AR-glasses while working in the automotive industry; the glasses show every step of the work process, identifying the needed tools and delivering guidance as well. This kind of AR is of particular interest when training special tasks. The learning contents catch somebody´s eye directly.

Another example for this scenario, but with a different technology, can be found at the University of Linz. They employ a special platform of information, communication, collaboration and navigation (SICS Smart Information Campus System), which was developed on the basis of digital-graffiti-technology. Affiliates of the university – teachers, students, administration – can offer elements of information documents like text, picture, sound, video and so on geo-positioned or drawn directly at mobile equipment on site. Teachers display documents for their (virtual) classes in front of the lecture room. Before entering the room the documents will be offered to the students automatically. A so-called friendfinder component allows collaboration and social networking. SICS (Smart-Information Campus System)-users are able to connect to other SICS-users (friends, colleagues, professors and so on), so that they are able to exchange their current geographic positions and start virtual dialogues (chat).

At a different scenario, at the European Mymobile Joined Project (Belgium, Germany, Italy and Great Britain) mobile portfolios, which produce a connection between everyday life and the formal institution of education, are mentioned. Therewith one of the crucial advantages of mobile learning is used, namely the creation of *user generated contexts*. This is context that is produced from learners themselves, because mobile equipment makes it possible to

develop synergies of knowledge which arise in most different societal, social and temporal contexts (see Pachler et al. 2012, p. 12).

6.5.3 Application during Classroom Teaching

This scenario depends on time and place. The use of mobile technology occurs in a physical context. A typical example for this is the well-known classroom situation in a classic and – nowadays still mostly overcrowded – auditorium (different to the Fernuniversität). Teachers do not only give lectures, but also formulate questions or tasks offering response options. Students can choose their preferred answer via their digital device. The results are transferred to the computer in real-time and can even be displayed to all attendants.

The target is to actively involve the students in class and to give the teacher the possibility to for example gather opinions or feedback and directly react to lack of knowledge, if necessary. Meanwhile, election clickers are not needed any longer, good apps are existing instead (i.e. Polleverywhere, Socrative, Pingo, ARSNova and so on). Students can answer with words, sentences or predefined responses, but they can also compete against each other in learning teams. A didactic target insisted is, that students not only listen but actively participate in class via smartphone, tablet (or laptop). Some classic learning platforms like ILIAS increasingly start to offer live voting plugins.

6.5.4 Usage in Distance Learning respectively Virtual Presence

In this scenario of mobile learning not place is important, but time. For example, this is the case, if an online lecture in form of a live stream or Google hangouts takes place. The participants gather at a certain date, but their location is totally irrelevant. This scenario is an outstanding opportunity to reach students worldwide. This way exams can be held independent of location. Teachers and students arrange an appointment in digital meeting rooms. Students can also participate in online surgeries or online lectures via mobile applications like Adobe Connect Mobile. A complex commute for a lecture of one hour becomes obsolete. Also students can use these possibilities to connect globally und take part in online lectures of educational opportunities worldwide (like MOOCs, for example).

6.6 Mobile Learning in Practice – A Reality Check

The potentials of mobile learning technology are evident and could improve scenarios in higher education as well. Thus in the following section the realization of mobile learning in higher education is analysed. Based on a general overview of where mobile learning is headed we take a deeper look into how mobile learning is currently implemented at German universities.

6.6.1 Mobile Learning Settings in Higher Education

According to Zhang (2015b) mobile learning is still behind its potential, because of technological shortcomings like an unstable internet connection, costs and safety. Thus she recommends to use mobile learning additionally to classical teaching and learning – as blended learning (Zhang, 2015b). For Zhang mobile learning is not ready to replace classical teaching and learning yet. Besides the technological limitations, a complete understanding of the requirements of a good mobile learning design is missing (Zhang, 2015a). But this is particularly necessary, because the situations mobile devices are used in are totally different

from former learning situations. Mobile devices only have small screens to display content or interact and students access mobile content anywhere and with just limited time (Zhang, 2015a). Furthermore, she describes students today as different "and ready for different learning methods and technologies" (Zhang, 2015a, p. 13), because they grow up with digital media and mobility, traveling and getting into exchange with different cultures (2015a). Petrakieva (2015) agrees that students are more used to digital media, but still need to be taught, how to use technology to enhance learning. She points out, that to offer digital content or to use automated feedback technologies does not make real mobile learning or even blended learning. It is not just about the access to digital content that counts, but a "proper m-learning and m-teaching strategy, with support for both educators and learners to fully benefit from m-learning" (Petrakieva, 2015, p. 976).

Petrakieva develops a mobile learning requirements hierarchy based on the idea of Maslow's hierarchy of needs, but she puts together two stakeholder perspectives – the students' and the educators' (2015):

- Students: access to device, internet access, ICT skills, attitude;
- Educators: access to technology, pedagogy, ICT skills, flexibility.

Similar to Zhang, for Petrakieva mobile learning still is a question of access, followed by the affordance of ICT skills to both stakeholders. The main challenge for the educators is to really produce mobile learning and not just make e-learning accessible through mobile devices (Petrakieva, 2015).

Pimmer, Mateescu and Gröhbiel (2016) analysed 36 studies on mobile learning in higher education to figure out what kinds of mobile learning exist and what the results are in education. As most researched subjects they identified language learning, health science and computer science. Their research especially focuses on the question, which kind of mobile learning settings is realized in higher education. They found out, that most of them are based on instructional design patterns, followed by constructionist learning and situated action. There were hybrid settings, which consisted of a combination of these. These four categories can be divided into sub-categories to structure the findings and to display the state of research in mobile learning (Pimmer, Mateescu & Gröhbiel, 2016).

Interactionist approaches

- Ad hoc and post hoc transmission of lectures;
- Supplementary text and multimodal materials;
- Activation and formative assessment.

Constructionist approaches

- Designing linguistic representations (written and recorded speech);
- Designing visual representations (photographs and videos).

Situated approaches

- Situated action and contextual scaffolding.

Hybrid approaches

- Hybrids of situated, constructionist and collaborative design, link of formal and informal learning settings, collaboration and exchange.

There is no question that mobile learning reached universities. Mainly due to the spread of

smartphones and tablets in society and everyday usage also by students. This strategy of BYOD saves the universities money in case of the hardware but requires much more staff support to ensure connectivity of all different devices (Petrakieva, 2015). Universities themselves start to align their offer to the demands of their target group and want to profit from the advantages and potential of mobile learning (Sousa Pereira et al., 2016). The market growth of smart portable devices and the flood of emerging apps facilitate integration and open up new possibilities of teaching and learning. Pereira et al. (2016) analysed helpful apps for higher education focussing on apps that support organising and administration tasks and on apps promoting well-being or mental health for students. Next to super ordinated apps, which provide general information about higher education most universities in Portugal offer their own apps to students to administrate their studies.

To sum it up, mobile learning is still struggling with access to technology and interoperability. Moreover, there is still a lag of mobile learning scenarios based on didactical concepts and which benefit from contextual integration. Instead interactionist and constructionist approaches are the dominant form in higher education.

6.6.2 Comparison of Mobile Learning in Higher Education in Germany

After this look into the variety of technological and pedagogical/didactical possibilities of mobile learning in higher education, in this paragraph mobile learning at top universities in Germany is analysed. The universities were selected based on the official CHE ranking 2016/2017. Using the CHE ranking, users can find the best university in each study programme rated by different criteria. First of all, ten study programs with the highest numbers of students were selected from official statistic (Statista, 2015/2016). These were business studies, mechanical engineering, economics, medicine, German language and literature studies, psychology, educational science and electrical engineering (Statista, 2015/2016). Secondly, the ranking was used to find the best state universities. As selection criteria, online offer – E-Learning – or, if this criteria was not available, the general study support, was chosen. E-Learning means the evaluation of quality and distribution of online offers (CHE Hochschulranking, 2016/17). General study support includes different items concerning support to network, mentoring, organisation, access to and quality of study materials. It came down to seven study programs, which had top flight results. Medicine was eliminated, because both criteria were not tested, as well as educational science, where there was no top flight at all. These two criteria were chosen to figure out, which universities are on top of learning with digital technologies or at least offer a high variety of student support. Comparing the rankings nine universities came up more than once in the top flight. Seven had two nominations; these are RWTH Aachen, University of Bayreuth, University of Bamberg, University of the Armed Forces Hamburg, Karlsruhe Institute of Technology (KIT), University of Hannover and Technical University of Munich (TUM). Two universities had top listings in three study programs, the University of Mannheim and the University of Ulm.

Following, the mobile learning offer of these nine universities were compared in two steps. In the first step we searched the websites of the universities with the terms mobile learning and mobiles Lernen. As second source of information we checked whether the universities provide learning apps in apple's App Store and Google's Play Store. Because these are the

dominant operating systems on smartphones with a market share of 90% in 2015 (Schmidt, n.d.), no other operating systems were taken into account.

Looking at the homepages of the universities mobile learning is not a prominent topic. Even e-learning needs to be tracked down. A search of the terms mobile learning and mobiles Lernen showed no relevant results at University of Bamberg and RWTH Aachen. Up to 40 results can be found at the KIT, 12 with the English term (Et) and 28 with the German term (Gt) mainly about a special training for school teachers, and at the University of Mannheim there are 30 results (Et) mainly publications and two results (Gt) linking to old news. Between 71 and 102 search results are listed at University of Hannover, 71 (Et), these are mainly links to events. On the website of the University of the Armed Forces Hamburg there are 61 results for the English term linking to projects and publications and 14 results (Gt) with a strong focus on publications. At TUM 71 results (Et) were found directing to publications and events and nine results (Gt) to events and projects. The longest list were the results at University of Bayreuth with 60 (Gt) and 42 (Et). The main subject, the results linked to, was the research unit on mobile learning at the university.

According to the provision of apps, mobile learning is not of high priority. The University of Bamberg and the University of the Armed Forces Hamburg do not provide any apps. The University of Hannover did not develop an app but participates and uses the app Stud.IP (which they use as learning management system) and the Technical University of Munich only got an unofficial android app developed as a faculty project.

All apps can be ranked according to their functional scope. The one with least functions is KIT-Navigator (Karlsruhe Institute of Technology), which just helps to navigate the campus. Some more features are offered by University of Bayreuth, University of Mannheim and University of Ulm, they included all kinds of information which might be useful for students, like the menu of the cafeteria, events, news or links to further information. Two apps are able to deliver individual information and integrate personal study schedules, Stud.IP (University of Hannover) and TUM Campus App (Technical University of Munich). In the former one students can also download material or use forums. The app with the most functionalities that really provide learning features is the app of RWTH Aachen. Next to search, navigation, and all other functions mentioned so far, there are more administrative functions like get informed and register for events or check grades and schedule. Furthermore, the virtual learning environment L2P is integrated in the app as well as additional tools like quizzes and direct response systems.

Besides these main apps with core functionalities to organise students' lives, some universities supply additional apps to take on special tasks. Although there are quite a lot of apps developed by departments, faculties or as student project in any subject, this analysis focuses on apps to support learning in higher education.

RWTH Aachen and Karlsruhe Institute of Technology provide two more apps, one learning app and one organizing app. Both learning apps, Phyphox (physical experiments; RWTH) and Dein Klima (regional locations and climate change; KIT) are running on both operating systems. KIT Career Service is an android app, which delivers information and news about future career. Climbr is an app to book further education and training by RWTH and the only one targeting the university staff.

The University of Mannheim offers a library app: students can research literature and also look up free study desks. There are at least two more universities offering learning apps, TUM and University of Ulm. TUM fml is an android app developed by a single institute supporting two classes. eMed (University of Ulm) is an interactive learning application with quizzes and content management system.

To sum it up, looking at universities highly ranked due to their learning offer with digital technologies or student support, mobile learning is not a high priority issue. Two universities do not even have an app or any content on mobile learning on their websites. Astonishing is the fact, that on the one side the university of the Armed Forces do not have an app, but lists the most information (in a quantitative way) about mobile learning. While on the other side RWTH Aachen provides the most integrated app, but there is not even a single relevant search result with the term mobile learning on the website. The functionalities of the apps are mainly to organize student life or keep users up to date. Only two apps (RWTH Aachen and University of Hannover) contain learning materials. Further features to support mobile learning are only provided by rwthapp, namely a quiz and a direct response system. But further apps specialized on single subjects or content evolve enriching students possibilities to learn anywhere and anytime.

Broadening the scope besides apps, all universities use a virtual learning environment, mainly open source solutions; the University of Bamberg, Bayreuth, TUM and Ulm chose Moodle, the University of the Armed Forces, KIT and Mannheim use ILIAS and the University of Hannover Stud.IP. Only RWTH Aachen developed its own learning management system. All systems can be accessed with mobile devices either with the web browser or with an app.

Although the analysis just compared nine universities in Germany, a tendency of the development in mobile learning in higher education can be concluded. Together with the findings in the literature it becomes clear, that mobile learning primary is an object in research projects or pilot studies. There is just little evidence that it plays an important role in current university strategies. In the development of mobile applications universities put emphasis on organization and information. Moreover, learning features mainly stick to instructional approaches as Pimmer et al. (2016) pointed out as well.

But single solutions by departments or faculties pop up. The only problem is that they are strongly related to specific subjects or tasks and cannot easily be transferred. This lack of scalability hinders fast and broad distribution of mobile learning apps. Examples to prove the opposite are the apps, belonging to learning management systems like Stud.IP, Moodle or ILIAS. But as said before a bare transfer of E-learning content to mobile devices cannot automatically be called mobile learning. Furthermore, apps are needed which provide mobile learning functionalities but can be adjusted and filled with individual content and tasks.

6.6.3 Summary and Future Questions

The development and maintenance of apps especially with interactive content, automated responses and multimedia learning materials is expensive and challenging. Thus the solution of the University of Hannover to use an open source learning management system like Stud.IP, which also runs an app, seems to be smart but limited in its mobile learning potential.

The apps so far mainly prolong the regular learning offer to mobile devices and in some cases they add special content like quizzes or functions (direct response systems). Some succeed in providing a seamless user experience, if app and virtual learning environment or browser based solutions are connected and distribute the same content and features.

Of course there are research project or single solutions, which are based on virtual reality (Albrecht, Folta-Schoofs, Behrends, & Jan, 2013; "Social Augmented Learning", n. d.), integrate context (Filipski & Forster, 2012), mobile collaboration (Wang, 2014) or mobile game based learning (Lee et al., 2016), but this is not part of everyday life at universities yet and scalable solutions are needed.

However mobile learning technology does not have an inherent value or improve education just because of its existence. Didactical designs with concrete tasks and involved teachers are necessary to integrate mobile learning into existing scenarios or to initiate new ones (Pimmer et al., 2016). Pimmer et al. conclude that "the simple availability of creative and apparently empowering media does not per se lead to changed and enriched learning and teaching practices in higher education" (Pimmer et al., 2016, p. 498). It is necessary to involve, engage and prepare students as well as teachers to properly use digital media for mobile learning. Petrakieva sums up that "there is nothing natural in using technology for learning […] Simply providing access to it to educators and learners will have a very minimal and limited effect" (Petrakieva, 2015, p. 978). Moreover, it should be taken into account that in higher education the adoption of technology to enhance learning is slow (Pimmer et al., 2016). Especially in Germany administrative structures and privacy concerns limit and slow down technological developments.

Obviously mobile learning is arriving at universities in particular because there is no other chance. Students will continue to use smart mobile devices and this certainly will increase even more. Therefore they will demand more content and functionalities to support their student lives. But there is no entire turn in teaching yet.

6.7 Digital Turn with mobile learning at Universities – Consequences for the Understanding of Learning and Education at Universities

Altogether apps and scenarios visualize the evolution towards a consistent learning support (Ubiquituous Learning) respectively to a seamless learning. Meant is a transition from informal and formal settings of learning, the transition of personalised and social settings of learning, the transition of a physical area and digital information or the transition between different devices respectively different learning activities (see Specht et. al., 2013, p. 2; de Witt et al., 2016).

The end of the digital turn has not yet come. In future all applications will happen on one surface and the jumping between apps will disappear. Bots respectively digital assistants will execute our learning orders via voice input or text input. Apps will become so-called `invisible service-contractor of a messenger or bot´, which will also finish the download of apps. More and more human language will become the new user-interface and digital assistants will run apps on smartphones or tablets in the background (Schmiechen, 2016).

If our learning becomes smarter, it does not mean, that universities are allowed to be satisfied with a *learning to go*. Learning, which is aimed on educational formation and training, is still connected with strain and work. With a stronger digitalisation of university teaching there is to be followed: Students are offered huge resources of knowledge outside universities like online lectures or online articles in the internet and nowadays they are naturally roaming

the social networks, leading their own blogs, taking part in MOOCS and so on. They start to turn to informal learning processes outside regular courses more frequently and take part in designing informal learning rooms themselves, for example on facebook. Looking at MOOCs and Open Content the question remains who to consider an expert. The question is whether the internet is a *pool of knowledge* or rather sciolism.

In the future the role of universities should not entail to be an institution of exams, where students get the OER from outside, and only to be certificated at. Universities should be interested in further innovative development of university teaching and contemplate, that most university teachers themselves – still – hardly use new technology, neither for learning, teaching nor research. And yet they are still the experts and able to evaluate the quality of resources. Therefore, their task will be the support of students and enable them to recognize reliable sources and to examine content of high-quality.

The *net generation* including a great part of its students use their mobile equipment not only to ask for educational knowledge but also to be co-constructor of virtual learning rooms. They bring in new perspectives in terms of openness towards new forms of digital learning. Their social behavior shows the ability of participation and actively taking part in the internet. On the other hand, more and more (self-)responsibility is being demanded. They grow increasingly responsible for their own studying and qualification. University teachers need to assess the value of education, which digital media and mediated communication have according to provide orientation in the ever-changing relation of self and world. The key question is how changes of the world influenced by internet and digitalisation change relationships between human beings and the world. Mediated (learning) spaces became places of social meeting and these social meeting rooms in the internet gained essential importance and serve as orientation. Today education is mostly interfered by media and the result of learning processes in context of digital media.

References

1st International Conference on Learning Analytics & Knowledge 2011. LAK'11. (2010). URL: https://tekri.athabascau.ca/analytics/ Last accessed: 27 March 2017.

Albrecht, U.-V., Folta-Schoofs, K., Behrends, M., & Jan, U. von (2013). Effects of Mobile Augmented Reality Learning Compared to Textbook Learning on Medical Students: Randomized Controlled Pilot Study. *Journal of Medical Internet Research* 15(8). doi: 10.2196/jmir.2497.

Aljohani, N. R., & Davis, H. C. (2012). Learning Analytics in Mobile and Ubiquitous Learning Environments. In M. Specht, M. Sharples & J. Multisilta (Hrsg.), *Mobile and Contextual Learning. Proceedings of the 11th International Conference on Mobile and Contextual Learning 2012*. Helsinki, Finland. URL: https://eprints.soton.ac.uk/342971/. Last accessed: 19 April 2017.

Arnold, P., Kilian, L., Thillosen, A. & Zimmer, G. M. (2015). *Handbuch E-Learning: Lehren und Lernen mit digitalen Medien*. Bielefeld: Bertelsmann.

Azuma, R. T. (1997). A Survey of Augmented Reality. *Presence: Teleoperators and Virtual Environments* 6(4), 355-385.

Baumgartner, P. (2006). E-Learning-Szenarien – Vorarbeiten zu einer didaktischen Taxonomie. In E. Seiler Schiedt, S. Kälin & C. Sengstag (Eds.), E-*Learning – alltagstaugliche Innovation*? (pp. 238-247) Münster: Waxmann.

Bräuninger, M., Haucap, J., Stepping, K., & Stühmeier, T. (2012). *Cloud Computing als Instrument für effiziente IT-Lösungen.* HWWI policy paper No. 71. Hamburg: Hambug Institut of International Economics. URL: http://hdl.handle.net/10419/64866. Last accessed: 19 April 2017.

Bundesnetzagentur (n.d.). Entwicklung des Datenvolumens im Mobilfunk in Deutschland von 2005 bis 2015 (in Millionen Gigabyte). In *Statista – Das Statistik-Portal*. URL: https://de.statista.com/statistik/daten/studie/172798/umfrage/datenvolumen-im-deutschen-mobilfunkmarkt-seit-2005/ Last accessed: 27 March 2017.

Butgereit, L. (2016). An Exploration into Mobile Gamification in an Information Technology Classroom. In H. Crompton & J. Traxler (Eds.), *Mobile learning and STEM: Case studies in practice* (pp. 244-262). New York: Routledge.

Cano, E. (Ed.). (2017). Innovative practices for higher education assessment and measurement. Hershey: Information Science Reference.

CHE Hochschulranking (2016/17). Deutschlands größtes Hochschulranking. URL: http://ranking.zeit.de/che2016/de/. Last accessed: 19 April 2017.

comScore. (n.d.). Anzahl der Smartphone-Nutzer in Deutschland in den Jahren 2009 bis 2016 (in Millionen). In *Statista – Das Statistik-Portal*. URL: https://de.statista.com/statistik/daten/studie/198959/umfrage/anzahl-der-smartphonenutzer-in-deutschland-seit-2010/. Last accessed: 19 April 2017.

Crisp, G. (2007). *The e-Assessment Handbook*. London: Continuum.

Crisp, G. et al (2011). Teacher's handbook on e-assessment: a handbook to support teachers in using e-assessment to improve and evidence student learning and outcomes. Ottowa: Australian Learning and Teaching Council.

Czerwionka, T., Klebl, M., & Schrader, C. (2010). Lecturing Tomorrow: Virtual Classrooms, User Centered Requirements and Evaluative Methods. In M. Ebner & M. Schiefner (Eds.), *Looking Toward the Futur of Technology-Enhanced Education: Ubiqiutous Learning and the Digital Native* (pp. 353-372). Herschey: Information Science Reference.

Davie, N., & Heß, M.-T. (2012). Studierende nehmen Mobile Learning selbst in die Hand. Ergebnisse einer Umfrage an der Fachhochschule Südwestfalen in Meschede. *eLMagazin* 9, 14-15.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From Game Design Elements to Gamefulness: Defining `Gamification´. In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments* (pp. 9-15). New York: Acm. doi: 10.1145/2181037.2181040.

Diehl-López, J. (n. d.). Von WAP bis LTE: Die Geschichte des mobilen Internets.URL: http://t3n.de/news/geschichte-mobiles-internets-537616/. Last accessed: 27 March 2017.

Filipski, C., & Forster, U. (2012). Die „Lernorte" als augmented reality in der Hochschullehre praktisch umgesetzt in der „mobilen lehre hohenheim". *eLMagazin* (09), 16-17.

Glover, I., & Latif, F. (2013). Investigating perceptions and potential of open badges in formal higher education. In J. Herrington, A. Couros & V. Irvine (Eds.), *Proceedings of World Converence on Educational Multimedia, Hypermedia and Telecommunications 2013.* (pp. 1398-1402). Chesapeake: AACE.

Goertz, L. (2014). *Digitales Lernen adaptiv. Technische und didaktische Potenziale für die Weiterbildung der Zukunft.* Gütersloh. URL: https://www.bertelsmann-

stiftung.de/fileadmin/files/BSt/Publikationen/GrauePublikationen/LL_GP_DigitalesLernen_final_2014.pdf. Last accessed: 27 March 2017.

Handke, J., & Schäfer, A. M. (2012). E-Learning, E-Teaching und E-Assessment in der Hochschullehre: Eine Anleitung. München: De Gruyter.

Herber, E., Schmidt-Hertha, B., Zauchner, S. & Kierlinger-Seiberl, S. (2011). Erwachsenen-und Weiterbildung. In M. Ebner & S. Schön (Eds.), L3T Lehrbuch für Lernen und Lehren mit Technologien, 1-7. URL: http://l3t.tugraz.at/index.php/LehrbuchEbner10/article/view/36. Last accessed: 27 March 2017.

Hochschulforum Digitalisierung (2016). *The Digital Turn – Hochschulbildung im digitalen Zeitalter*. Arbeitspapier Nr. 27. Berlin: Hochschulforum Digitalisierung. Berlin: Edition Stifterverband.

Jansen, M., Hoppe, U., & Bollen, L. (2017). Technologiekonzepte zur Unterstützung mobiler Lernszenarien durch Cloud Computing. In C. de Witt & C. Gloerfeld (Eds.). *Handbuch Mobile Learning* (in print). Wiesbaden: VS Springer.

Kerres, M., & Voß, B. (Eds.) (2003). Digitaler Campus. Vom Medienprojekt zum nachhaltigen Medieneinsatz in der Hochschule. Münster: Waxmann.

Kleinmann, B., Özkilic, M., & Göcks, M. (2008). *Studieren im Web 2.0. Studienbezogene Web- und E-Learning-Dienste.* Hisbuskurzinformation 21. URL: https://hisbus.his.de/hisbus/docs/hisbus21.pdf. Last accessed: 19 April 2017.

Lee, H., Parsons, D., Kwon, G., Kim, J., Petrova, K., Jeong, E., & Ryu, H. (2016). Cooperation begins: Encouraging critical thinking skills through cooperative reciprocity using a mobile learning game. *Computers & Education* 97. doi: 10.1016/j.compedu.2016.03.006.

Lübcke, M. (2016). *BeForE –2016. Bericht Foresight in Higher Education*, Foresight Report 3. Zürich: Zürcher Hochschule für Angewandte Wissenschaften. School of Management and Law. Zentrum für Innovative Didaktik (ZID). URL: https://www.zhaw.ch/storage/sml/institute-zentren/zid/upload/bericht-foresight-in-higher-education-2016.pdf. Last accessed: 19 April 2017.

Mell, P., & Grance, T. (2011). *The NIST Definition of Cloud Computing. Recommendations of the National Institute of Standards in Technology.*Special Publication No. 800-145. Gaithersburg, MD: National Institute of Standards and Technology. U.S. Department of Commerce. URL: http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-145.pdf. Last accessed: 19 April 2017.

Metzger, D., Jannaber, S., Berkemeier, L., & Thomas, O. (2017). Aus- und Weiterbildung mit Smart Glasses und Virtual Reality-Brillen im technischen Kundendienst im Projekt Glassroom. In C. de Witt & C. Gloerfeld (Eds.). *Handbuch Mobile Learning* (in print). Wiesbaden: VS Springer.

O'Connor, E. (2012). Next Generation Online: Advancing learning through dynamic design, virtual and web 2.0 technologies and instructor attitude. *Journal of Educational Technology Systems* 41(1), 3-24.

Pachler, N., Seipold, J. & Bachmair, B (2012). Mobile Learning: Some theoretical and practical considerations. In K. Friedrich, M. Ranieri, N. Pachler & P. de Theux, (Eds.), *The "My Mobile" Handbook. Guidelines and scenarios for mobile learning in adult education* (pp. 11–16). Brussels: Media Animation.

Paramythis, A., & Loidl-Reisinger, S. (2004). Adaptive Learning Environments and e-Learning Standards. *Electronic Journal on e-Learning* 2(1), 181–194.

Petrakieva, L. (2015). Mobile Technologies and Learning: Expectations, Myths, and Reality. In Y.A. Zhang (Eds.), *Handbook of mobile teaching and learning* (pp. 11–25). Heidelberg: VS Springer.

Pimmer, C., Mateescu, M., & Gröhbiel, U. (2016). Mobile and ubiquitous learning in higher education settings. A systematic review of empirical studies. *Computers in Human Behavior* 63. doi: 10.1016/j.chb.2016.05.057.

Schmidt, H., (n. d.). Marktanteile der Betriebssysteme an der Smartphone-Nutzung in Deutschland von Dezember 2011 bis Februar 2015. In *Statista –Das Statistik-Portal*. URL: https://de.statista.com/statistik/daten/studie/170408/umfrage/marktanteile-der-betriebssysteme-fuer-smartphones-in-deutschland/. Last accessed: 03 April 2017.

Schmiechen, F. (2016). Das Ende der Apps, wie wir sie kennen. URL: http://www.gruenderszene.de/allgemeine/ende-der-apps. Last accessed: 24 March 2017.

Sherman, W. R., & Craig, A. B. (2003). *Understanding virtual reality: interface, application, and design*. Amsterdam: Morgan Kaufmann Publishers.

Social Augmented Learning. (n. d.). URL: http://www.social-augmented-learning.de/. Last accessed: 19 April 2017.

Sousa Pereira, A., Moreira, A. A., Chaló, P., Sancho, L., Varela, A., & Oliveira, C. (2016). Development Challenges of a Full Integrated App in Higher Education. In L. Briz-Ponce, J. A. Juanes-Mendez & F. J. García Peñalvo (Eds.), *Handbook of research on mobile devices and applications in higher education settings* (pp. 1-24). Hershey: Information Science Reference.

Specht, M., Ebner, M. & Löcker (2013). Mobiles und ubiquitäres Lernen. Technologien und didaktische Aspekte. In M. Ebner & S. Schön (Eds.), L3T. Lehrbuch für Lernen und Lehren mit Technologien, 1-11. URL: http://www.pedocs.de/volltexte/2013/8347/pdf/L3T_2013_Specht_Ebner_Loecker_Mobiles_und_ubiquitaeres_Lernen.pdf. Last accessed: 27 March 2017.

Wang, S. (2014). Collaboration Factors and Quality of Learning Experience on Interactive Mobile Assisted Social E-Learning. *Turkish Online Journal of Educational Technology* 13(2), 24-34.

Wegener, R., Bitzer, P., Oeste, S., & Leimeister, J. M. (2011). Motivation und Herausforderungen für Dozenten bei der Einführung von Mobile Learning. In *Informatik 2011 –Informatik schafft Communities*. Presented at the 41. Jahrestagung der Gesellschaft für Informatik, Berlin. URL: https://www.alexandria.unisg.ch/220256/1/JML_255.pdf. Last accessed: 19 April 2017.

de Witt, C., Karolyi, H., & Gloerfeld, C. (2016). Digitale Medien in der beruflichen Bildung. Planung und Umsetzung von Seamless Learning. In C. Kreklau & J. Siegers (Eds.), *Handbuch für Aus- und Weiterbildung* (pp. 1-30) Köln: Wolters Kluwer Verlag.

Zhang, Y. A. (2015a). Characteristics of Mobile Teaching and Learning. In Y. A. Zhang (Eds.), *Handbook of mobile teaching and learning* (pp. 11–25). Heidelberg: VS Springer.

Zhang, Y. A. (2015b). Design of Mobile Teaching and Learning in Higher Education: Introduction. In Y. A. Zhang (Eds.), *Handbook of mobile teaching and learning* (pp. 3–10). Heidelberg: VS Springer.