Beyond Delivery Modes and Apps: A Case Study on Mobile Blended Learning in Higher Education

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Abstract. Mobile learning has received an increasing attention by the TEL community since 2010. While much research is available on the effectiveness of individual apps and educational approaches and despite that many higher education institutions introduced special mobile learning apps, relatively little is known about the rationale of scaling up mobile learning in higher education institutions. It reports on a case study, in which a mobile app solution has been integrated into a lecture at a major Swiss university. The study analyses the student's use of mobile media and the use of a smart-phone app in a mobile blended learning setting. The results indicate that today's students live in a multi device environment and are likely to use mobile apps in new contexts and settings if this is supported by an app. They also show that mobiles will not replace other delivery modes or technologies. Instead, the findings indicate that students used the mobile learning solution for extending and enriching their learning environment. Therefore, this study suggests that mobile learning needs to blend into rich learning environments, in which they co-exist with paper books, classroom experiences, laptops, and tablets. The insights define new requirements for both, mobile apps and virtual learning environments, in order to meet the future challenges of TEL in higher education.

Keywords: Blended Learning, Case-study, Device Ecologies, Device Usage, Educational Design, Evaluation, Higher Education, Mobile Learning, Seamless Learning

1 Introduction

Scaling up technology enhanced learning in traditional higher education requires much didactical and technical reasoning. This is even more the case when new technologies are integrated into an already technology enhanced environment. Educational technologists working with mobile learning solutions find themselves often in a situation to work with both, enthusiasts who will follow a new technological trend for the technologies sake and the pragmatists who reasonably argue that the existing

adfa, p. 1, 2011.

technology is satisfying their and their students' educational demand. The study underlying this paper started from integrating a mobile solution into a university course that is already setup following a blended learning approach in order to better understand the requirements, attitudes, and practices of lecturers and students towards using mobile technologies.

This paper reports on the initial findings of using a mobile micro-learning solution in a blended learning lecture in a major university in Switzerland during the fall semester 2014. The underpinning case study addressed the framing, attitudes, and practices of using mobile learning in a blended university lecture. While a lot has been written on mobile learning tools, architectures and educational designs, scaling up mobile learning into higher education practice needs to take a broader perspective beyond usability and attractiveness. Yet, very limited research is available on the technological framing in which mobile learning solutions should be used, while at the same time many higher education institutions are rolling out mobile apps. Typically, generic market studies such as [1] are used as reference, but it has been reported that the reality within an organization can divert significantly from the general market [2].

Scaling up mobile learning also requires well-understood educational concepts. Wong and Looi [3] introduced the educational design concept "seamless learning". Seamless learning is anchored in mobile learning because contextualizing learning is a distinct aspect addressed by mobile learning research [4]. Seamless learning abstracts approaches and practices for bridging and linking learning experiences across contexts, among which is bridging or linking learning across space and time. While these two characteristics are genuine to flexible learning and have been inherited by blended learning, it has been claimed that special approaches using mobile technologies can expand the existing notion [5, 6].

The present research grounds on the concept of "mobile blended learning". This concept refers to educational designs that include mobile devices for special learning activities in combination with other learning educational approaches and technologies. Compared to common use of "blended learning" [7, 8, 9] the added "mobile" highlights that learning activities differ for each technology used in the learning scenario. Therefore, it goes beyond device related content adaptation and "responsive design".

Unlike seamless learning, mobile blended learning refers to educational designs without considering learning contexts other than the device dimension. The smaller focus of mobile blended learning allows addressing questions on contextual implications of technologies and instructional designs that help to develop a better understanding for the interplay of educational experiences and technological affordances in seamless learning.

2 Question for Research

The present case study responds to the need of contemporary higher education institutions to introduce technological innovation in education while many technological and conceptual uncertainties exist. At the same time new approaches in TEL are un-

likely to remain isolated. Instead, they are used in combination with established tools and concepts. This raises concerns about the usefulness of extending educational toolkits. Therefore, it is required to address the technological and educational benefit of integrating mobile learning into the mainstream practice. Consequently, the present study tackles the following question in order to provide a baseline for scaling up mobile blended learning in higher education.

What benefits does mobile technology contribute to an already technology enhanced learning environment?

In order to answer the primary research question, two subordinate questions were isolated. Through these questions this study seeks to integrate the techno-social perspective as well as the educational technology perspective.

The first question addresses the technological ecosystem and the related practices of university students by asking: what technologies are available and practices are common to students in higher education? Answering this question provides insights on the technological status quo that allows relating to broader oriented market studies. The resulting information also allows estimating potential areas for investment in infrastructure, tools, or practice development.

The second question focuses on the mobile technology-related affordances for contextualizing learning in a higher education setting by asking: are there intrinsic context-related affordances that allow to bridge learning activities into uncommon contexts? This question addresses a design problem for operationalizing seamless learning as well as for contextualization. The problem is to what extent "context" has to be explicitly considered in an educational design and to what extent it is already inherent to the tooling. This aspect influences the perception of lecturers and instructional designers regarding the complexity of integrating seamless learning.

Given the scope of the present study it is impossible to provide comprehensive generalisable answers. The responses to these questions might not be directly transferrable to other organizational and national contexts or to different tool arrangements. However, by addressing these questions this study connects the organizational and the educational-design dimensions; and thus contributes to the development of a better understanding of the baselines for using mobile technologies as parts of broader technology-enhanced learning environments in higher education.

3 Method

The case study has been conducted as part of an introductory lecture on media studies and communication science at a major Swiss university. The lecture is mandatory during the first term of the related bachelor program and is repeated annually. Consequently, the lecture's curriculum and learning resources have been standardized, while professors of the institute rotate the responsibility for holding the lecture every academic year. One or more teaching assistants support the professor. The lecture has already implemented a voluntary online component using the university's learning management system. The teaching assistants primarily maintain the lecture's online component. The existing online learning material consists of references to reading

material, the lecture slides, a discussion forum for subject matter related questions, a discussion forum for organizational questions, and a question pool that is used for self-assessment throughout the duration of the lecture as well as for the final exam.

The lecture has been extended by the mobile micro learning [10, 11] app "Mobler Cards" [12] in order to evaluate the feasibility of providing mobile learning support in this introductory lecture. The solution builds on the existing self-assessment resources. Providing more timely learning opportunities to the students and to estimate their adoption of such an added service has motivated this extension of the lecture using a mobile tool.

3.1 Mobile App Integration Into the Blended Learning Setting

Mobler Cards is a smart phone app that implements a flashcard learning inspired micro learning approach. Micro learning is defined as the arrangement of minimal and complete learning activities [10]. A learning activity is complete if it consists of a task affordance, a learner action, and a feedback that is provided to the learner in response to the action. A learning activity is considered minimal if it cannot be further separated into smaller complete learning activities. Mobler Cards uses test items as micro learning activities and repeatedly presents them to a learner (Fig. 1). Test items are particularly suitable for micro learning because they consist of a question (task affordance), require a learner response to the question (learner action), and define rules for assessing the learner response for providing feedback.

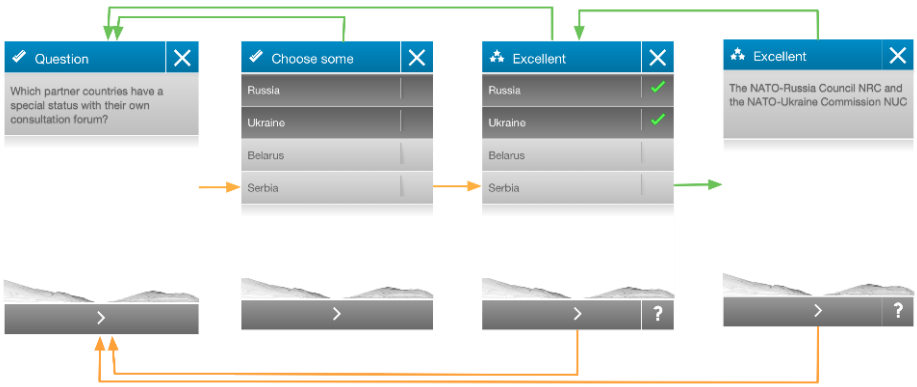

Fig. 1. The Mobler Cards' Micro Learning Loop with screen captures

Mobler Cards is designed for easy integration into online learning environments and for the repurposing of existing learning resources. For this purpose, the app relies on three REST services for connecting to learning management systems: a content broker, a learning record store (LRS), and a learner profile.

The content broker service selects app suitable learning material for the learners' settings. It uses the learning management access control to determine, which content is available on the learners' personal devices. This way content can be personalized

according to the learners' courses, to their learning path, to their performance, or to the timing in a course. Timing was the only parameter for parameterizing the content broker during the present case study.

The LRS provides a unified way for storing traces of learning experiences. The LRS used by Mobler Cards is defined by the Experience API (XAPI) specification [13]. The LRS is at the core for orchestration and information functions of the Mobler Cards app [14].

Finally, Mobler Cards uses a learner profile service. This service informs the app on a student's preferences and the courses, into which the student is enrolled.

All services are present for the learning management system as well as for the app itself. This way the app decouples student interaction with the service synchronization. This is a prerequisite for the fully offline function of Mobler Cards. The app can connect to LMSes by following the principles of the ADL Training and Learning Architecture (ADL TLA) model [15]. This enables a bi-directional integration of the Mobler Cards app into the learning environment. The integration architecture is illustrated in Fig. 2.

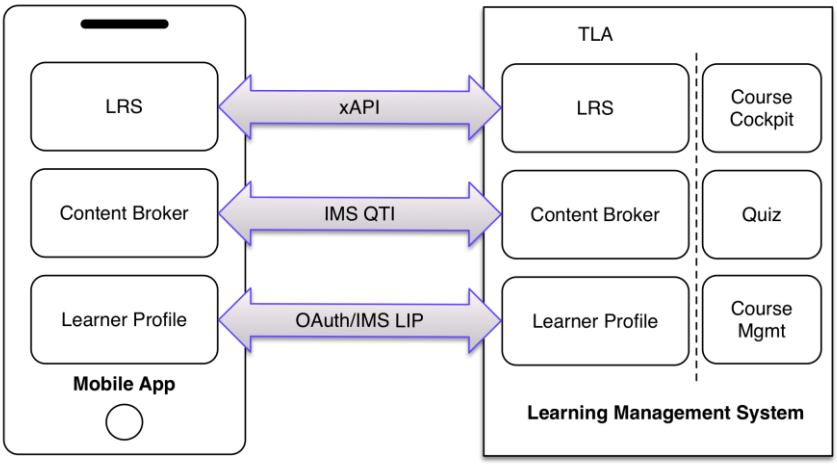

Fig. 2. Architecture for the Mobler Cards-LMS integration

3.2 Instructional Design of the Mobile Blended Learning Settings

The lecture has been conducted as a weekly face-to-face lecture with 13 sessions throughout the fall semester 2014. As an introductory lecture, the lecturer presented an overview of the theories and concepts of the subject with minor student interaction during the face-to-face sessions. At the end of the semester a final written exam tested the students' knowledge on these topics. The exam took place 3 weeks after the last face-to-face session.

Each session briefly repeated the key points and theories of the preceding session and provided the students the opportunity to request clarification on difficult aspects.

Given the size of the lecture, students often do not raise questions or indicate their challenges in understanding certain concepts. To overcome this barrier the lecture included special online quizzes that were made available to the students each week. The quiz results were used as an indication on the concepts that were well understood and those that were challenging for the students. A quiz consists of 5-8 test items. Similar but not the same questions were used for the examination. After the last session the quizzes were extended with additional questions in order to support the students' exam preparation. In total 125 test-items were presented in the quizzes. The number of attempts per quiz was not limited.

The Mobler Cards app used the same test-items as the weekly quizzes. After each session during the term new questions were included into the app. Therefore, the number of items that were presented to the students grew towards the end of the term. Finally, for exam preparation all additional questions were also added to the question pool. Each attempt to answer a question was stored in the LRS at the LMS and provided the input for the course cockpit. In the course cockpit the course facilitators are able to see the average student performance for each test-item. Additionally, the cockpit provides an overview on the student activity with respect to the app. For organizational reasons the app was promoted with a one-week delay after the online quizzes.

Both, the Mobler Cards app and the conventional online quizzes were voluntary for the students and had no influence on the students' grades. Compared to other practices, the test-items were entirely teacher authorized and managed the same way, both, online and mobile. This way the students were assured that all questions reflect the topics that are relevant for the lecture's exam.

3.3 Data-Collection and Analysis

To answer the question regarding the technological framing as well as to identify the qualitative aspects of using Mobler Cards a survey has been conducted after the lecture's final exam. All students of the lecture were invited to participate in the survey.

The survey includes items regarding mobile device adoption and usage, regarding the usage context of Mobler Cards in a mobile blended learning setting, as well as items regarding the perceived usability of the app. The items covering the device adoption and usage were taken from a market study [1] as well as from a prior study on mobile device adoption in a professional education context [2]. The items on the contextual device use were taken from the same survey and adapted to match the concrete scenario of the case study. The items on the perceived usability are based on commonly used usability evaluation sheets [16, 17]. The items consist of nominal scales, Likert scales and open questions for qualitative feedback. The survey was implemented as an online questionnaire using the EvaSys system [18], which is the source for the reported descriptive survey results. The usability scales in the survey were only displayed to those participants who used the app.

In addition to the data from the survey quantitative data provided by the app and the learning management system has been used to triangulate the intrinsic contextual

factors of the technology used in this setting. Mobler Cards automatically records each attempt answering a question in the LRS. The entries in the LRS include references to the test-item, the time of the attempt, the duration of the attempt, and the score for the answer. The duration of the attempt is defined by the time from accessing answer perspective of the test-item for the first time until the answer is submitted to receive the feedback. The score is defined as 0 for wrong answers, 0.5 for partially correct answers, and 1 for correct answers.

The LRS of the learning management system integrates the attempts for all students into a single activity stream for the entire course in the XAPI JSON format. This activity contains only Mobler Cards records. In a second step the activity stream is anonymized for a descriptive comparison with the online quizzes.

To measure the participation in the online quizzes and the app, the ratio between the active students and the total number has been calculated. This calculation has been chosen because no data on the weekly participation in the face-to-face sessions could be collected for that lecture.

4 Results

410 students participated to the lecture that provided the framing for this case study. From the student records 300 students were identified as female and 109 as male. At the end of the term 125 students (30%) used Mobler Cards at some point during the semester. Among these students were 38 students (9%) who used the app at least on 5 different days throughout the semester. In the following this group is referred as "frequent learners". The seemingly limited uptake of the app might be related to different launch dates for the mobile app and the online quizzes.

During the semester on average 201 students (49%) voluntarily completed each online quiz before the next session and on average 225 students (55%) completed each online quiz during exam preparation.

In total the students responded 13298 times to the test items using the mobile app, while the students who used the app frequently account for 65.3% of the responses. On average each test item has been answered 108 times (∂ = 59.9) by 47.2 students (∂ = 15.8) using the mobile device and answered each test items on average 2.2 times (∂ = 0.5). The frequent learners have responded on average 228.6 times (∂ = 142.0) to the test items.

All participating students used the app in 547 sessions with on average 24.3 responses (∂ = 33.5). Among the students the number of sessions greatly varies between 1 and 21 sessions, while on the average student used the app in 4.4 sessions (∂ = 4.2). For the frequent learners the average number of session was 9.6 (∂ = 4.11). During the sessions the students responded on average to 24.3 test-items (∂ = 33.5). Compared to the frequent learning group there is little difference with respect to the amount of responses given per session (μ = 23.9, ∂ = 28.5).

The sessions were not equally distributed throughout the semester. The data shows that the students were more active at the beginning of the semester and towards the exam (Fig. 3, Fig. 4). For the frequently learning students a more continuous partici-

pation has been detected. Although in this group the activity reaches a low between week 8 and 11 (Fig. 3), these students account for almost all responses during this period. This shows that these students used the app more continuously.

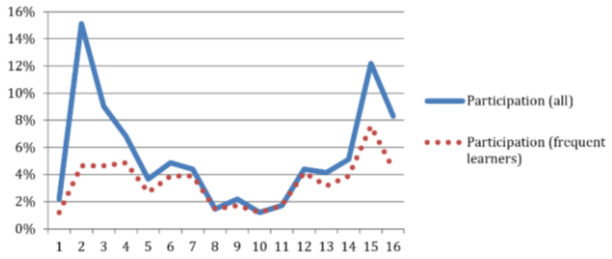

Fig. 3. Weekly Mobler Cards usage during the semester and exam preparation

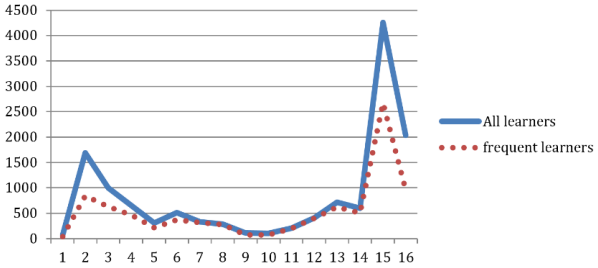

Fig. 4. Weekly number of test item responses in Mobler Cards

While in absolute terms the online quizzes were used more intensively than the mobile app (72194 test items answered), the average online test item has been answered 1.4 times during the lecture phase (∂ = 0.2) and 1.7 times during exam preparation (∂ = 0.1) in this mode. The participation and the number of responses were declining the later a topic has been taught during the semester. This trend is observable during the lecturing phase as well as during the exam preparation. These trends are depicted in **Fig. 5** and **Fig. 6**. The data also shows that the students were using the online quizzes more intensively during the exam preparation phase than during the rest of the semester.

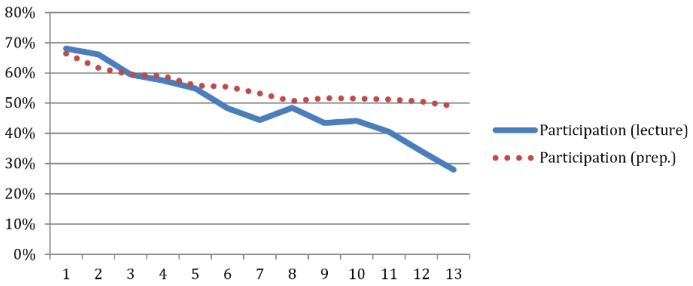

Fig. 5. Participation to the online quizzes during the lecture and the exam period

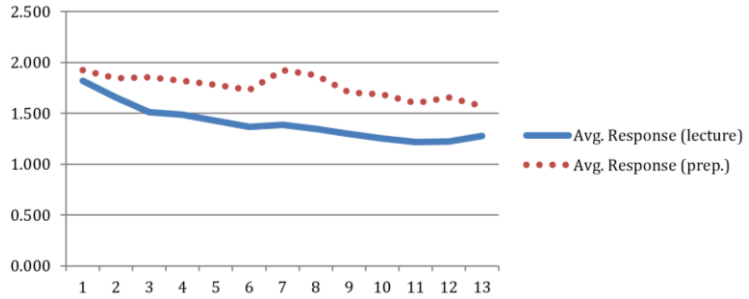

Fig. 6. Responses to test-items in the online quizzes during the lecture and the exam period

At the end of the case study 50 students (12%) completed the online survey after their exam. Considering that the online survey has been conducted already during the semester break a 12% response rate is considered a success.

4.1 Device Adoption and Use

The first section of the survey dealt with student's ownership und usage of mobile devices. Participants were interviewed on which smart phones they have, where and how often they use smart phones as well as what services they apply frequently. Finally, they were asked about other frequently used mobile devices.

All students who participated in the survey report to own smart phones with a dominant share of iPhones of 72%. Respectively, they report to use the following mobile operating systems: Apple iOS 72%, Android 26%, and Windows 2%. Almost all respondents use their smart phones every day at home (98%), on the way (92%) and at the university (92%). Slightly less smart phones are used in leisure time (86%) and at work (69%).

Smart phones are not the only mobile devices owned by students. Also notebooks (92%) and tablets (48%) are used frequently. The majority of the students (64%) responded that they use frequently 3 or more mobile devices at the time and 34% use 2 devices together.

The answers to the question about frequently used services indicate that the respondents do not use their smart phones as gaming devices often. Only 18% of respondents play every day on their smart phones, but just as many do not play at all, 24% play less frequently than monthly, 22% monthly and 18% weekly.

As Fig. 7 shows the most popular everyday used services and apps on student's smart phones are: texting (94%), online search (74%), social networking (72%), online services such as blogs and news (62%), e-mail (61.2%), and photos (52%). Other services are used less frequently: camera (50% weekly), navigation (52% weekly), telephony (52% weekly) and videos (44% weekly). Responses to the open-ended question about the 5 most important apps used on mobile phones correspond to the distribution of responses represented in Fig. 7. The students mentioned 54 apps they use frequently on their smart phones. The most popular app is WhatsApp followed by navigation apps (such as maps and public transportation apps), news apps, Facebook

and e-mail. Gaming apps were mentioned only three times, which underlines the limited relevance of gaming for this audience.

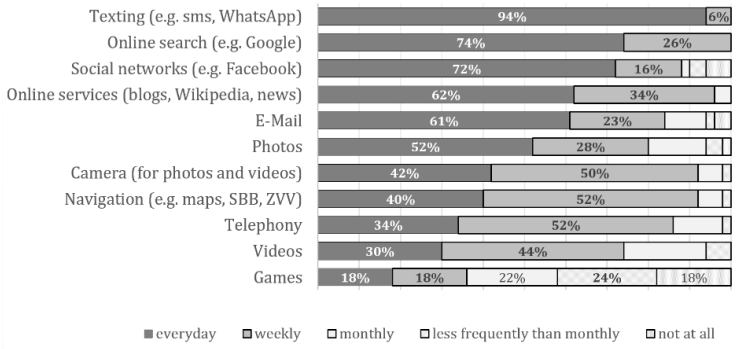

Fig. 7. Responses to the question: "How frequently do you use the following services on your smart phone?"

4.2 Device Usage for Learning

The second part of the survey focused on students' usage of the Mobler Cards app during the lecture. Students' feedback as well as their opinion about the further development of the app and its integration in other courses was of particular importance for the study.

12 students stated that they learned with the app regularly, 16 occasionally and 9 used the app only once. The remaining 13 participants have not used the app at all: 6 of them pointed problems with installation and the authentication. 3 students solved the quizzes using LMS. 4 students have not specified any reason.

Students have preferred to learn at home (weekly 38.9% and monthly 22.2%) and on the way (weekly 36.1% and monthly 25%). When working (not at all 84.4%), in leisure time (not at all 75%) and at the university (not at all 66.7%) they hardly used the app. (Fig. 8). This data has been also confirmed by the data from the activity stream.

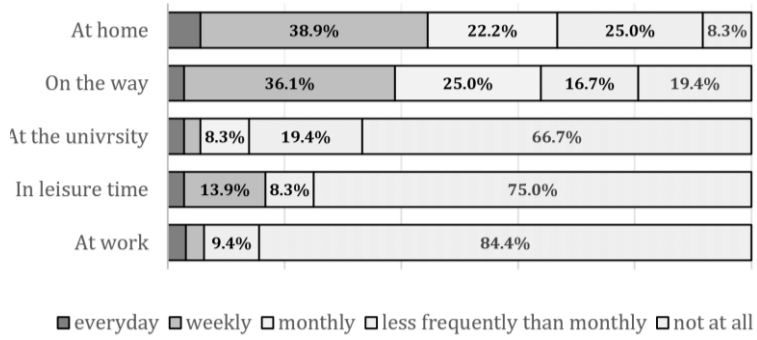

Fig. 8. Responses to the question: "Where and how often have you used the mobile app?"

4.3 App Usability

The rating of the app concerning technical implementation, usability and its integration in the lecture was very positive. While all of survey respondents, who used the app (n=37) had positive experience with app installation and the majority of them with operation (91.9%), the usability of the app was rated a little bit less positive: the user interface was easy to understand for 77.8% of these participants, attractive for 59.9% and functional for 85.7%.

Especially good rating achieved didactic integration of the app in the lecture. All respondents agreed that the app is a useful addition to the course. 91.8% of students mention that Mobler Cards is useful for learning. 97.1% stated that the app did not create unnecessary workload for learning. 91.9% considered the app as a useful addition to LMS quizzes ($\mu = 5.5$, $\partial = 0.7$) and complementary to the online quizzes ($\mu = 5.1$, $\partial = 1.3$). However, the respondents disagreed with the replacement of the conventional LMS quizzes by the mobile app ($\mu = 3.4$, $\partial = 1.9$).

Most students would continue to use the app voluntarily; few 5.6% would only use the app if it would be a compulsory part of the lecture ($\mu = 1.5$, $\partial = 1.1$). A better integration of the app in the lecture would not necessarily lead to a more frequently app usage at large: only 55.8% of students claim that they would learn with the app more frequently.

The opinions are diverse concerning the motivational aspect of the app: 57.1% of students stated that the app helps them to learn more regularly and 51.3% are motivated to learn more intensively. 91.6% of students would recommend learning with the app to their fellow students.

All students are of the same opinion about the future of the Mobler Cards app: it should be offered in the future, but it should be developed further and adapted to their needs (97.3%). Furthermore, 86.5% of respondents would appreciate the app integration into other courses.

Table 1. Responses to the open question: „What do you like about the mobile app?"

Response	**n**
Context aspects	
Learn at any time and at any place	7
Learn in the short time, e.g. on your way	6
Optimal for learning with mobile phone	3
Ease of use	2
Didactic aspects	
Useful addition to the lecture	3
Questions weren't divided into sections / many questions	3
Possibility for exercise, repeat, and verification	3
Simple but good questions / well formulated sentences	2
Learning statistics	1

Particularly pleasing is the fact that many students have expressed their feedback and suggestions for app improvements. Students justified their positive attitude towards the app by noting that they can learn with the app at any time, at any place and within a short time on their way. Also the students emphasized didactic aspects in their feedback (Table 1).

Improvement suggestions focused primarily on didactic aspects. 11 out of 26 students find that the division of available test items in lecture topics is very important. Also students would like to be able to choose whether they answer all available test items or only test items of a particular topic. Furthermore, they would like to highlight or store such test items in a separate folder in order to have a possibility to repeat them later.

5 Conclusions and Further Research

The presented case study focused on the integration of a mobile learning solution into a blended learning curriculum in a university lecture. The solution was a mobile micro learning app that repurposed the lecture's test-items for more "casual" learning activities. The lecture served as a pilot in order to develop a better understanding on the practical conditions and constraints of expanding the technological support. Two questions were addressed by this research through a mixed method approach involving a survey and learning activity records.

The first question asked for the technologies that are available to the students and what are common practices of using them. The results of this case study indicate that already more than two-thirds of the responding students are commonly working in a multi-device environment with 3 or more devices. Although smart phones are available to all respondents, they were by no means the technology of choice for all learning activities. Furthermore, the findings indicate that smart phones are tools to support communication, collaboration and orientation, while gaming was not very relevant to the respondents. These results are in line with earlier findings, which suggest that they draw a realistic picture of the lecture's audience. This baseline enables lecturers and professors to realistically estimate the impact of mobile technologies on their students. Most important here is that concerns regarding the digital divide are today closer related to platforms rather than to the access to technology as such. An insight that tool developers and instructional designers must consider as well. However, the present data only provides a narrow image of the situation in higher education. Particularly, large-scale studies and course evaluations should therefore consider including additional items to expand the understanding of the students' technological framing.

The second question addressed the intrinsic context-related affordances of mobile learning tools for bridging learning activities into uncommon contexts. The survey results indicate that the students were using the app primarily at home or while commuting. Some students reported that they used the mobile solution during leisure time such as being out with friends. The use on the campus was not relevant to them. It was no surprise that the app wasn't used in the workplace because the majority of freshmen at the university are entering directly after school. These results indicate that

the students were using the app for expanding their learning time into contexts that were previously unavailable to them. The usage data from the frequent learners suggests that this can help students to balance their workload towards the exam preparation. The effects can be only related to the technology-intrinsic affordances because the educational design of the lecture as well as the learning resources did not suggest, promote, or encourage particular uses. This finding is relevant because it indicates that predefined application settings and the limitation to specific environments, such as the university campus, might be too limited to match the students' learning needs. The difference between technology-intrinsic and educational design affordances has not been considered by previous research. Especially, for the emerging field of seamless learning separating these dimensions is important for isolating the causes of the observed effects.

These findings allow a preliminary answer to the overarching research question on the benefits of mobile technology for already technology-enhanced learning environments. The results show that contemporary students are already living embedded in a technological ecosystem and that they are willing to use different tools to make more efficient use of their study time. Therefore, integrating mobile tools into a blended learning curriculum does not imply to fully replace existing approaches, methods, or tools. Instead, mobile technologies can enrich and balance the overall learning experience in a multi device environment. The related educational design challenge is to define practices and tools that enable such enrichment in a multi-device environment by creating the traits that enable students and lecturers to reach out to and bridge between contexts that were previously unavailable for studying. Consequently and within its limitations, this case study suggests that design decisions regarding technology-enhanced learning should be rather guided by the interplay of the different devices used by the audiences than by unifying the experience across devices.

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