MOBILE DEVICE USAGE IN HIGHER EDUCATION

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ABSTRACT

This paper focuses on mobile device usage of students in higher education. While more and more students embrace mobile devices in their daily life, institutions attempt to profit from those devices for educational purposes. It is therefore crucial for institutional development to identify students' needs and how mobile devices may facilitate these needs. This longitudinal study with $N = 172$ students compares the use of e-Readers and tablets for learning at a higher education institution. While e-Readers offer inexpensive solutions for reading texts, tablets provide a much wider range of applications, such as communicating with other students, accessing learning management systems, or conducting research online. Findings indicate that students evaluate tablets as a more useful device for learning. Interestingly, students using tablets also start to include more and more mobile learning technologies into their learning strategies.

KEYWORDS

Mobile device usage; e-Reader; tablet; mobile learning technology

1. INTRODUCTION

The use of mobile devices of higher education students has been on the rise for years. As more and more people integrate mobile devices into their personal life (Dahlstrom, Brooks et al. 2015, Poll 2015) educational institutions are including new technologies into their teaching systems to benefit from the distribution of mobile devices. This includes advanced infrastructure such as computer rooms accessible for students, digitalisation of library systems, as well as the development and implementation of learning management systems with the goal to maximize the use of mobile devices while maintaining the purpose of education (Al-Emran, Elsherif et al. 2016). Aligning students' needs with institutional offers is one of the current challenges. Gikas and Grant (2013) state that students are unlikely to involve a certain mobile device into their learning behaviour, if they do not benefit from it. Simply distributing devices to students will not facilitate educational success of an institution. To distinguish useful devices from less useful ones, it is therefore important to have a closer look at actual students' needs and compare them with the features a mobile device can offer. In 2015, researchers at the University of Mannheim and the Baden-Wuerttemberg Cooperative State University Mannheim (DHBW Mannheim) conducted a longitudinal study focusing on the use of e-Readers for students in higher education. E-Readers were characterized as inexpensive tools able to widen an institution's range of utilised media devices. Although e-Readers proved to be useful for the students' task of reading texts, additional important features were missing: students mentioned the ability to make annotations in a piece of text, search the internet for further information or use the learning management system of the institution as important for their learning needs. As a result, a follow-up study comparing tablet-computers with e-Readers was conducted. The paper consists of three parts. In the first part, relevant theoretical considerations are being made with respect to current literature and empirical work. Six hypotheses have been constructed as a result of the literature review. The second part outlines the survey methodology and the results of the survey. In the final part, the results of the survey are being interpreted and connected with the preliminary considerations.

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2. LITERATURE REVIEW

2.1 Students' Tasks in Higher Education

The tasks of students at higher education institutions are manifold. Each category requires a variety of skills, competences, and tools allowing students to be successful learners in higher education. Fundamental tasks are information literacy and academic learning skills including (1) attending classes (including preparation and post processing), (2) preparing for / taking exams, (3) handing in written papers (or comparable assignments) (Stagg and Kimmins 2014). In the following chapter, the three categories will be explained in greater detail. However, several skills, competences, and tools cannot be assigned to a single category and not all of the challenges students face in higher education are included (Fook and Sidhu 2015). A comprehensive review would exceeds the boundary of the paper. Therefore, this review focuses on the tasks that can be supported through mobile devices.

Attending classes refers to the actual presence time at the respective institution. This includes taking part in mandatory lectures and tutorial groups as well as student workgroups. Students have to provide themselves with the course material, such as lecture notes and literature, to effectively handle the task of attending classes. In addition, students are securing important information in the classes by taking notes or creating audio-recordings. Securing important information helps students to follow and post process the current class and to prepare the upcoming class. This often includes performing further research (e.g., searching for information online) (Cohen, Kim et al. 2013).

Scripts, notes, literature, and the ability to conduct further research can be used in the process of preparing for exams. Time management is a necessary skill enabling students to effectively handle the workload in the stressful time in the pre-exam period. It is also needed to organize group work, which is a learning strategy often and successfully used by students (LaBossiere, Dell et al. 2016). In regard to this popular learning strategy, an important factor is the ability to communicate aspects of organization (meeting date and place, agenda) and content related topics (distribute helpful literature in a workgroup).

When working on written papers or other non-exam reviews, students not only rely on literature and information provided by lecturers. They have to search for additional information in online databases, libraries, and the Internet. This includes the ability to work with different texts and file formats. Apart from text files, information can sometimes be found in the form of video and audio files. These media files require further technology to be included in the student's learning process (Gosper, Malfroy et al. 2011, Rashid and Asghar 2016).

2.2 Mobile Learning – e-Readers and Tablets in Comparison

Gikas and Grant (2013) define mobile learning as a combination of three aspects. (1) Mobile learning as more than just learning delivered on a mobile computing device, (2) learning as both formal and informal, as well as (3) context aware and authentic for the learner. For the presented study, points (2) and (3) are especially important, because the curriculum of the DHBW Mannheim is based on the interaction of theory and practice. Students are spending half of the semester with theoretical studies at university and the other half of the semester doing practical work at companies. Mobile devices do not only allow students to have access to learning material while they are away from university, they can also include them in their practice time at work and for authentic learning situations (Gikas and Grant, 2013). Although a multitude of mobile devices for mobile learning have been developed over the last decade, students are mostly using laptops and smartphones, owned by over 90% of all students (Dahlstrom, Brooks et al. 2015). Additionally, a lot of students own e-Readers or tablets and include them in their daily learning (Dahlstrom, Brooks et al. 2015).

The basic function of e-Readers is the display of text files, such as specific e-book-formats or PDF-files. They are equipped with a special display, which was developed to optimize the readability of text documents. E-Readers are lightweight, offer a wide viewing angle and only consume a small amount of energy, therefore combining mobility and readability (Lin, Wu et al. 2013). Pollock (2012) observes e-Readers as not being capable of fulfilling the demands of educational environments, such as displaying multiple columns, detailed illustrations, and mathematical equations or symbols. Further, they often do not support activities related to research-oriented active reading as well as note-taking and highlighting. Technical reports, maps, and charts are difficult to read because of graphics quality (Clark 2008). Improvements seem to be necessary to

strengthen e-Readers role in an educational context, for example the ability of browsing the internet (Hahto 2012), printing important parts of content (Miltenoff 2012), and improvements toward processing and performance speed (Shurtz, Gonzalez et al. 2012). The shortcomings of e-Readers may be reasons students do not see them as supportive for their study practices (Mallett (2010)). Nevertheless, e-Readers are characterized as "great for reading novels" (Mannonen, Nieminen et al. 2011), especially because of the eye-friendliness of the screen, weight and size of the device, as well as power of battery (Marmarelli 2010).

The most common e-Readers types are the Kindle (Amazon), the Kobo, Nook (Barnes and Noble), and the Sony Reader (Rainie, Zickuhr et al. 2012) with cost from 50€ up to 250€. Another notable product is the Tolino, a coalition of big bookstore companies, designed especially for the European market.

In comparison to e-Readers, tablets (e.g. Apple iPad) offer a much wider range of functions, while at the same time providing a similar mobility. Tablets can be described as a mixture of smartphones and laptop computers, equipped with technology to use mobile data, such as Bluetooth, Wi-Fi and LTE, but with a much bigger screen than the typical smartphone. Additional features such as microphones and cameras and the ability to install software in the form of apps are paired with intuitive usability (Ifenthaler and Schweinbenz 2013). The investigated problems of e-Readers in educational context can mostly be approached with tablets, because they allow access to the Internet (e.g. for researching further learning content). With the display keyboard, notes can easily be added to existing documents. Tablets can show 3D-models and complex simulations because of their advanced computing power. In terms of media files, video and audio files can also be rendered on tablets. Furthermore, technical features allow students to access learning management systems or use social media to connect with other learners. Students can install additional programs or applications on a tablet to structure and frame their personal learning process.

Tablets cost from 30€ to 1800€, with a wide variety of manufacturers and operating systems. Apple iPad, Samsung Galaxy Tab and Microsoft Surface are the most commonly used tablets with specific operations systems iOS (Apple), Android (Samsung) and Microsoft Surface.

A difference in fields of application for the mobile devices can be determined based on their technical characteristics and limitations. While e-Readers seem to provide as a good tool for reading text files, tablets offer a much wider set of functions. Table 1 compares e-Readers and tablets with regard to the tasks of students.

Table 1. Features of e-Readers and Tablets

Task	**e-Reader**	**Tablet**
Reading text files	Possible	Possible
Taking notes	Complicated/not possible	Possible
Browsing the internet	Not possible	Possible
Library research	Not possible	Possible
Accessing LMS	Not possible	Possible
Communication	Not possible	Possible
Additional media	Not possible	Possible

2.3 The Present Study

While the tablet looks superior in theory, it is questionable if or to what extend students are integrating the mobile device into their learning and how they rate the usefulness of the device. Multiple hypotheses for a comparative study were created, based on the theoretical assumptions of the previous chapters.

We assume that students are using tablets more often then e-Readers (Hypothesis 1). Students working with a tablet more often utilize technologies and features for learning (Hypothesis 2a). The difference between tablet and e-Reader users in this regard is getting bigger over time (Hypothesis 2b). When rating the usability of tablets for the personal learning process, tablets are rated better in comparison to e-Readers (Hypothesis 3a). The difference between tablet and e-Reader rating are getting bigger in the course of time (Hypothesis 3b). The technical feature of the tablets are rated higher than the technical features of e-Readers (Hypothesis 4).

3. METHOD

3.1 Design

This study compares the use of e-Readers and tablets at the Baden-Wuerttemberg Cooperative State University Mannheim (DHBW). The main goal was to investigate in which ways bachelor students integrate the mobile devices into their learning behavior and if there are significant differences between different mobile devices. Out of a group of 172 students two groups were chosen randomly and provided with an e-Reader or a tablet. Data was collected through an online survey at three different measurement points (start of semester, mid-semester and end of semester). At the first measurement point, students received their devices. They were asked to provide their email-address, which was later used to invite them to the online survey using the LimeSurvey tool.

3.2 Participants

In total, N = 172 students from 3 different classes (real-estate management, mechanical engineering, and business informatics) took part in the survey. 72.7% were male and 27.3% were female students, with an average age of 20.23 years (SD = 2.21). 26% of the students attended the real-estate management class, 35% studied mechanical engineering and 39% were business informatics students.

3.3 Instrument

At three measurement points (t1, t2, t3), slightly different questionnaires were used, consisting of 31 (t1), 19 (t2) and 41 (t3) items. In most cases, a seven-point Likert scale (7 = I totally agree; 6= I agree; 5 = I agree partially; 4 = I don't know; 3 = I disagree partially; 2 = I disagree; 1= I totally disagree) was used to evaluate the students' opinions and perception towards the devices. Moreover, open questions were used to collect information about positive and negative aspects of the devices. The factors have been successfully tested for reliability with Cronbach's alpha $.775 \leq r \leq .904$.

3.4 Data Analysis

The collected data was anonymized, exported and analyzed using SPSS V.23. Initial data checks showed that the distributions of ratings and scores satisfied the assumptions underlying the analysis procedures. Out of the initial 172 students, 127 datasets could be used for analysis. All effects were assessed at the .05 level.

4. RESULTS

4.1 Hypothesis 1: Frequency of Mobile Device Use

Students were asked at measurement three (t3) to provide the frequency they used the mobile device on a scale from 1 to 7 (1 = multiple times a day, 2 = daily, 3 = multiple times a week, 4 = once a week, 5 = multiple times a month, 6 = once a month, 7 = less than once a month). An independent-samples t-test was used to compare the amount of time students spent using the mobile devices. The t-test showed a significant difference between the time spent on using the mobile device between students with e-Readers (M = 6.40, SD = 1.24) and students with tablets (M = 2.58, SD = 1.73), $t(127) = 14.48$, $p < .01$. The results suggest, that there is a difference between the amount of time students spend on using e-Readers and tablets. Specifically, the results suggest that tablets are used a lot more often than e-Readers. E-Readers are approximately used once a month, while the tablets are used multiple times a week.

4.2 Hypothesis 2a: Use of Technologies and Features for Learning

Students were asked which technologies and features they use as part of their learning on a seven-point Likert scale (1 = no use; 7 = very high usage intensity). 13 different features and technologies were chosen, e.g.. online research, online library, online database, communication application, video platforms, social media platforms, and learning management systems (LMS). For analysis, a variable was created, grouping the specific intensity variables together into a single intensity variable for each measurement point. A high value represents a high use of technologies and features while a low value represents a low use of technologies and features. An independent-samples t-test was conducted to compare the use of technologies and features between the two mobile device groups at measurement points t1 and t3. There was no significant difference between e-Readers (M = 42.58, SD = 12.12) and tablets (M = 41.64, SD = 11.31) at measurement point t1, $t(127) = .0457$, $p = 0.648$. Similar, no significant difference between e-Readers (M = 43.68, SD = 13.25) and tablets (M = 47.09, SD = 11.34) was found at measurement point t3, $t(127) = -1.57$, $p = .118$. thus, hypothesis 2a has to be rejected. The results suggest that students using tablets and e-Readers do not vary in the intensity of technologies and features used for their personal learning behavior.

4.3 Hypothesis 2b: Increased Difference over Time

Although we could not find a significant difference in the intensity of used technologies and features between e-Readers and tablets, a change in intensity over time might be observable. A paired-samples t-test was used to compare the usage intensity of technologies and features in the course of time within the two device groups. For the tablets, there was a significant difference between t1 (M = 41.64, SD = 11.31) and t3 (M = 47.09, SD = 11.34), $t(63) = -3.76$, $p < .01$. For the e-Readers there was no significant difference between t1 (M = 42.58, SD = 12.12) and t3 (M = 43.68, SD = 13.25), $t(64) = -.582$, $p = .56$. The results suggest, that while there is no significant change in the intensity of used technologies and features for e-Reader users over time, the tablet group uses technologies and features more frequently after working with the devices for some time.

4.4 Hypothesis 3a: Rating the Usability for Learning

Students were asked to rate the usefulness of the device they were equipped with. Four items were used to determine the perceived usefulness (“Using the device for learning is a good idea”, “Using the device for learning makes learning more interesting”, “Using the device for learning is fun” and “I like working with the device”) on a seven-point Likert scale (7 = I totally agree; 6= I agree; 5 = I agree partially; 4 = I don’t know; 3 = I disagree partially; 2 = I disagree; 1= I totally disagree). Those four items were computed into a group variable for further analysis. An independent t-test was conducted to compare the perceived usefulness for personal learning between the two devices. There was no significant difference between the rating of e-Readers (M = 20.52, SD = 5.18) and tablets (M = 21.64, SD = 3.74) at t1, $t(127) = -1.401$, $p = .164$. The results suggest, that the use of e-Readers and tablets was not perceived different at the beginning of the study. At the end of the study, there was a significant difference between the rating of e-Readers (M = 15.00, SD = 7.23) and tablets (M = 21.00, SD = 5.23); $t(127) = -5.392$, $p < .01$. The results show that there is a difference between the perceived usefulness between e-Readers and tablets at the end of the term. More specifically, e-Readers are perceived as less useful in contrast to tablets.

4.5 Hypothesis 3b: Increased Difference over Time

While there was not a significant difference between the perceived usefulness between e-Readers and tablets at the beginning of the study (hypothesis 3a), there was a significant difference at the end of the study. Because of the observed values from the statistical tests, we assume that the usefulness of tablets is not changing much from t1 to t2. In comparison, the perceived usefulness of e-Readers differs significantly between t1 (M = 20.52, SD = 5.18) and t3 (M = 15.00, SD = 7.23), $t(64) = 6.54$, $p < .01$. The results suggest that e-Readers are perceived much less useful after working with them for a term.

4.6 Hypothesis 4: Technical Features of Tablets

Students were asked to evaluate the technical features the devices provide, namely "access to the Internet", "access to a literature platform", "good readability", "long lasting battery", "access to additional lecture material", "flexibility to use content on multiple devices", "costs of books and lecture material", "adding notes to documents", "adding bookmarks", "lecture coverage with the provided scripts and books". On a seven-point Likert scale the students could rate the features from 1 = "totally not relevant" to 7 = "totally relevant". The items were grouped into a new variable to measure the frequency of ratings. 22% of the students rated the total features as relevant and 56.6% as very relevant. The majority (79%) of students evaluated the features of the tablet as relevant for their learning strategies.

5. CONCLUSION

The findings of this study identified differences between e-Readers and tablets. This underlines the importance of a planned mobile device usage for mobile learning at higher education institutions. The amount of time spend with a device is suggesting the usefulness of the mobile device. Literature clearly identified limitations of e-Readers (Clark 2008, Hahto 2012, Mallett 2010, Miltenhoff 2012, Shurtz, Gonzalez et al. 2012). The limited applications and sole purpose as a reading device for non-coloured, pure text files does not make it a very attractive mobile device for students. In hypothesis 4 the technical features of tablets could be identified as very relevant to students learning process. In reverse, a lack of those features can be described as not supportive for the students' learning strategies in higher education (Gosper, Malfroy et al. 2011).

Hypothesis 2a and 2b suggest an important feature of tablets: The integration of technologies and features such as online research, library access or accessing the learning management system facilitate learning at higher education institutions. Tablet users tend to utilize the available technologies significantly more often after working with the mobile devices for some time, while the e-Reader users do not change their behavior significantly. It might be possible that the further use of tablets leads to an observable significant difference between the two mobile devices. This could mean that the tablets do enable and motivate students to use more of the available mobile learning features. As a result, tablets can be interpreted as catalyst for further engaging with mobile learning. It is important to note that the feature and technologies students rated in the survey might not be used because they don't fit into the needs of the student. In the theoretical part we already hinted at the fact that students don't use technology that isn't useful for them (Gikas and Grant 2013). As an example, students might not use the learning management system because they don't profit from it, be it through the lack of content or usability. Such a phenomenon could blur the measurement of students' technology and feature usage, because in return, a learning management system that is perceived as effective by students would have a bigger impact on the rating.

The attitudes of students towards technology and features at the beginning of the term (the first measurement point) are indications for the quality of the sample. No bias between the two groups can be found at the start of the survey. The same assumption can be made with regards to hypothesis 3a, where no differences between the groups could be found. This can be interpreted as both groups having the same overall attitude towards the devices and especially trying to integrate devices into their learning strategy at the start of the survey (Al-Emran, Elsherif et al. 2016). The statements made by the students at a later point in time were therefore mainly influenced by the use of the mobile devices.

One of the most interesting aspects of the data analysis is the fact that tablets don't achieve higher ratings after the usage. The difference between the devices is based on a decreased rating of the e-Readers. This can probably be caused by a disappointing user experience with the e-Reader. At the start of the survey, the participants were most likely happy and excited about the opportunity to work with a new mobile device without having to worry about financial issues or if they would really need to have the device. The limits of the device have been mentioned in previous parts of the paper (Clark 2008, Hahto 2012, Mallett 2010, Miltenhoff 2012, Shurtz, Gonzalez et al. 2012). It is very likely that students were disappointed by the e-Readers because of its limited features and usability. The disappointment could have been enhanced by the fact that the other group of students got a 'superior' mobile device.

The assumptions derived from the data analysis can be transferred to students from other higher educational institutions offering similar features and technologies that can be accessed with a mobile device. The observed differences between the mobile devices will most likely become more apparent at institutions providing more and better features of mobile learning, such as well-engineered learning management systems or when lectures include mobile learning into their classes. It is important to notice that lecturers didn't use more special content (e.g. more online materials, higher use of audio or video files) during the survey. This probably has a big impact of the perceived usefulness of the mobile devices. The survey presented in this paper will be extended for another term to collect data towards this assumption. More materials and more features being accessed via tablets will be implemented at the DHBW Mannheim soon. This will increase the amount of data available for analysis, which is especially interesting for the assumptions made towards hypothesis 3. It will be interesting to see if the assumed catalyst effect will lead to a measurable significant difference between the two devices.

As a limiting factor, the high costs of effective tablets must be seen. It is rather difficult to provide a bigger group of students with those devices. If institutions of higher education want to include mobile devices into their media portfolio, they will most like have to equip research teams with additional funding to purchase those devices (Gikas and Grant 2013). Although 127 participants offer a good basis for the quantitative research for this paper, further research must be conducted to enhance the view on mobile devices in the context of mobile learning. Apart from the aspects already mentioned, it would be interesting to see if there are differences between advanced students and freshmen. Tablets could help freshmen overcome the gap that is often mentioned when changing from high school to university. On the one hand tablets could enable them to cope with the new challenges higher education institutions posses, e.g. finding effective learning strategies and getting easy access to course material. On the other hand, advanced students might use other aspects of the mobile device more frequently, including research work or the organization of work groups.

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