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Use of learning media by undergraduate medical students in pharmacology

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List of abbreviations

Apps	Applications
CL	Conventional learning
E-books	Electronic-books
FG	Focus groups
ICT	Information and communication technology
JG	Joanna Gutmann
ML	Mobile Learning (m-learning)
PC	Personal Computer
Pharma	Pharmacology
UK	United Kingdom
WWW	World Wide Web

1. Introduction

Modern mobile computing devices such as smartphones or tablet PCs which have instant internet access have become almost ubiquitous among today's society (Payne et al., 2012; Traxler, 2008; Wallace et al, 2012) Globally the number of smartphones has crossed the one billion mark and it is estimated that it will surpass the two billion mark in 2016 ("2 Billion Consumers Worldwide to Get Smart(phones) by 2016," 2014).

1.1. Digital natives

The ubiquity of the internet and mobile computing devices led to a generation of students that grew up in this highly digitalized world with information and communication technology (ICT) as an integral part of their daily life's. „This generation of learners born between 1980 and 1994 were therefore termed as "digital natives" (Prensky, 2001) or "net- generation" (Tapscott, 1999) due to their presumed familiarity and reliance on ICT." (Gutmann et al., 2015). It was suggested that these digital native students have naturally integrated the potentials of digital information access and knowledge acquisition into their personal life's and studies (Prensky, 2001; Tapscott, 1999).

1.2. Mobile learning

Due to easy portability, wireless connectivity to the internet and numerous specialized applications (apps), these technologies offer on- the- go access to worldwide, up-to-date information resulting in a flexibility and independence never before possible (Gayeski et al., 2003).The use of mobile end-devices and the resulting unique way of learning is therefore consequently referred to as mobile learning (m-learning), although so far there has been no consensus on the term itself. For the purpose of this study we define "Mobile learning" as using digital learning media for medical education with mobile devices including all benefits that result from the portability and functionality of

the device itself, the instant access to the content of the World Wide Web (www) and the vast variety of applications (Sandars, 2013).

As a consequence, these mobile computing devices have created new and flexible possibilities for context-specific and immediate learning, especially while on the move, with the benefit of empowering the learner to create a uniquely personalized learning environment (Ally, 2009). Learning can now be delivered at any place and at any time, radically transforming the prevalent concept of knowledge and how it is generated, transmitted, owned, valued and consumed (Sandars, 2013; Sharples, 2000; Traxler, 2008; Traxler, 2009).

1.3. Impact of mobile learning on digital native student life's

Some authors even proposed different learning styles and behaviour of digital natives in comparison to their predecessors. „For instance, digital natives were suggested to be experiential learners, proficient in multitasking, comfortable with multimedia learning environments and the use of ICTs for interacting with peers and educators (Frand, 2000; Oblinger & Oblinger, 2005; Prensky, 2001; Tapscott, 1999). This led in part to the assumption that the present educational system might not be fully prepared to deal with the needs and expectations of today's student generation." (Gutmann et al., 2015).

Therefore, several authors believe that especially mobile access to information via modern digital handheld devices has the potential to further enhance medical education and patient care. Although a high ownership of mobile computing devices (Kühbeck et al., 2014; Robinson et al., 2013; Wallace et al., 2012) and usage of medical applications (Koehler, 2012) to support learning (Robinson et al., 2013) have been published, there is also an ongoing debate on the kind and level of learning media use by students and faculty in higher education (Harley et al., 2006). „Amongst others, Bennet et al. (Bennett, 2008) and Thompson (Thompson, 2013) criticized the limited

and underlying empirical evidence on the concept of digital native learning and concluded that the digital natives approach to learning and technology use varies and is complex rather than deterministic." (Gutmann et al., 2015). „For undergraduate medical education, some studies identified digital media as the predominant information source for medical students (Cooper & Elnicki, 2011; Leff & Harper, 2006; Peterson et al., 2004) whereas other authors reported non-digital learning media, notably textbooks, as medium of choice for personal study (Baudains et al., 2013). A number of studies have also investigated the use and acceptance of certain learning media or technology, e.g. e-books (Woody et al. 2010), mobile devices (Baumgart, 2011; Ellaway et al., 2014; Nguyen et al., 2015; Wallace et al., 2012) or Web 2.0 tools (Pander et al., 2014; Sandars et al., 2008) in higher education. "(Gutmann et al., 2015).

„However, only limited data is available on the quantitative and qualitative use of different learning resources by students in a genuine educational context and its longitudinal alterations" (Gutmann et al., 2015), as well as attitude and perceived impact of modern learning media on medical education.

2. Aims of this dissertation

Therefore, „[t]he aim of the study was for one, to systematically analyse use and acceptance of learning resources by undergraduate medical students. For this purpose, we monitored the daily use of digital and non-digital learning media during a teaching module of pharmacology by an online questionnaire and analysed the overall media use and media choices in teaching vs. self-study periods." (Gutmann et al., 2015). Additionally, „semi- structured interviews were conducted at the end of the course to gain insights into the learning media preferences by students. "(Gutmann et al., 2015).

For another, we used focus groups to further explore the attitude towards digital, in particular mobile learning media in comparison to non-digital learning media such as textbooks and the perceived impact of mobile learning on medical education. For the purpose of an initial orientation, a short online survey about practical use and experience with digital learning media was performed prior to the focus groups.

3. Methods

For this investigation, two independent studies were conducted.

First a two-phased sequential mixed-methods explanatory design was employed consisting of a daily online survey and follow-up interviews to study the use of learning media by undergraduate medical students.

Second we facilitated focus groups for qualitative analysis in order gain in depth-insight into students' views and attitudes towards learning media in medical education with a prior online survey about practical use with digital learning media.

All study participants were students from Technische Universität München (TUM), Germany, who were enrolled in a pharmacology course at the Institute of Pharmacology and Toxicology.

Study participation was voluntary and informed consent was obtained from all study participants. All data were processed in an anonymized manner. Approval by the ethics committee of Technische Universität München (TUM) was obtained.

3.1. Quantitative data

3.1.1. Study design and participants

„The study was conducted with a cohort of 338 3rd year medical students, enrolled in a pharmacology course". „The module consisted of a 28-day teaching period with daily lectures and twice-weekly seminars, followed by a ten-day self-study period and a final written exam (Figure 1).

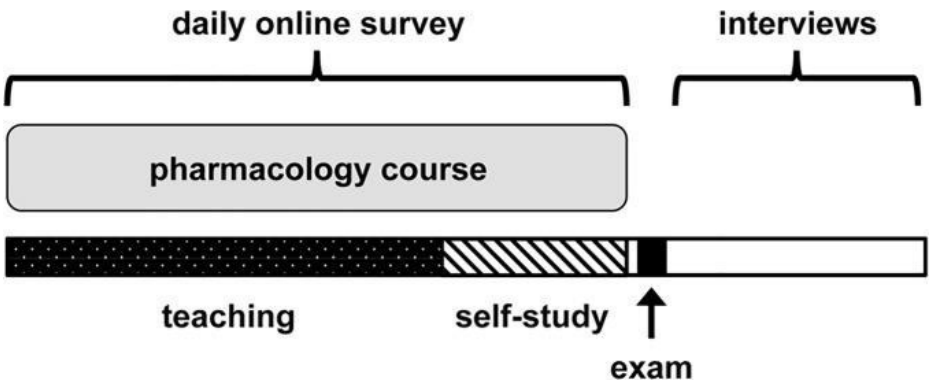

Figure 1. Experimental setting and timeline. (Gutmann et al., 2015)

Quantitative data were solicited during the lecture and self-study periods by a daily online questionnaire. For descriptive statistics of learning media use, the portions of votes per medium per day were calculated and averaged for the whole study period.

For the quantitative analysis prior to the focus groups, participants were asked to answer an online survey." (Gutmann et al., 2015).

3.1.2. Data collection, instruments and analysis

To collect quantitative data on learning media use in real time, a member of the research team, Felizian Kühbeck, developed a web-based survey tool that displayed a questionnaire to study participants in a daily manner. A web-based solution was selected to ensure compatibility with all common operating systems and devices. The survey tool was written in Hypertext Preprocessor (PHP) as server-side programming language to be compatible with all major operating systems, and connected to a MySQL-Database for storage and analysis of survey data. Adobe Dreamweaver was used to write the PHP-Code. Three-digit codes were generated at the beginning of the course and printed on small paper notes. Every student had to randomly pick a note. At the beginning of the course the students had to enter their codes, this ensured anonymous usage of the tool, but the results were collected per person. „The user interface consisted of a questionnaire soliciting information on the most, 2nd most and

3rd most used learning medium of the previous day. For each question, study participants could choose one item from a list of ten different learning resources (textbooks > 300 pages, textbooks < 300 pages, lecture slides, software applications for mobile devices (apps), internet search, e-learning cases, podcasts, e-books, personal notes, exam questions), or opt not to respond. The questionnaire was automatically displayed to study participants when visiting the online learning platform (www.tum300.de) used for pharmacology teaching at TUM. A cache memory function prevented multiple daily votes by single users." (Gutmann et al., 2015).

For the quantitative data collection about use of digital learning media an online survey was performed via Google.Docs, asking the students how frequent they have used apps on a mobile device, wikis, video-podcasts, audio-podcasts, social media platforms (Facebook), internet fora (medilearn.de), media sharing (Dropbox), learning e-cases or blogs (Doccheck) before for the purpose of their medical studies. The questionnaire is shown in Table 1.

- Have you ever learned with an application on a mobile device?
- Have you ever used wikis (such as Wikipedia) for your medical studies?
- Have you ever watched video-podcasts (such as youtube) for your studies?
- Have you ever listened to medical content via audio-podcasts?
- Have you ever used social media (such as facebook) to share medical content?
- Have you ever used medical internet fora (such as medilearn)?
- Have you ever used media sharing (such as dropbox) for your medical studies?
- Have you ever used medical e-learning cases?
- Have you ever read blogs (such as doccheck) about medical content?

Table 1. Online Questionnaire prior to Focus Groups.

3.1.3. Statistics

„Graphs are presented as mean ± standard deviation of the mean (SEM). To determine if the two sets of data are significantly different from each other, Student´s t-test was used. A two-way analysis of variance (ANOVA) with Tukey's multiple comparisons post hoc-test was used to compare the use of digital and non-digital media by male and female students. For statistical analysis, GraphPad PRISM 6.0 (La Jolla, CA) software was used. P values < 0.05 were considered statistically significant." (Gutmann et al., 2015).

For the online survey (n=15) of the focus group participants a categorical rating scale with four response options was used (1: yes, very often, 2: yes, sometimes, 3: yes, once, 4: no, never).

3.2. Qualitative data

Since focus group sessions and telephone interviews were totally conducted in German language, grammatical and context-sensitive error corrections were undertaken in the translation of the chosen citations into the English language for the purpose of publication.

3.2.1. Interviews

Participants and data collection

For qualitative analysis, semi-structured telephone interviews (n=11) were conducted after the exam with a sub-cohort of study participants via convenience sampling. "Following questionnaire data analysis, an interview guide was generated and pilot tested with non-participating students for clarity, relevance and interview length." (Gutmann et al., 2015). „All interviews were conducted by one researcher (JG) in the weeks following the exam and lasted ten to 15 minutes. After eleven interviews, thematic saturation was reached." (Gutmann et al., 2015).

Analysis

„The interviews were audio-recorded and transcribed verbatim using f4 transcription software (Dresing & Pehl, Marburg, Germany). Elements of grounded theory and constant comparison were used to identify and develop themes iteratively from ongoing data collection analysis (Maykut & Morehouse, 1994; Mills, Bonner, & Francis, 2006). The process involved line-by-line examination of each transcript by the interviewer and coding of phrases into themes." (Gutmann et al., 2015).

3.2.2. Focus groups

Participants

This part of the study was conducted with 1st year undergraduate medical students enrolled in a pharmacology course. For the three focus groups (FG) convenience sampling was used to select participants (n=18) by email and verbal advertisements during core lectures. Students were assigned to one of the three focus groups according to availability. The number of participants per session varied from 5 to 7.

Data collection

We facilitated focus groups for qualitative analysis in order gain in depth-insight into students' views and attitudes towards learning media in medical education. The FG discussions were moderated by one researcher (JG) and were facilitated using a semi-structured questioning route with open-ended questions, in order to ensure consistency across groups (Table 2). The questioning route was developed from literature review. Each session lasted approximately 120 minutes. Focus group sessions were held until no new significant topics emerged and data saturation was completed. Focus group setting and self- administered questionnaire were piloted with a group of volunteers. No field notes were taken during or after the focus group interviews.

Clarification of the term mobile learning (ML) in contrast conventional learning (CL) Exchange of practical experience with mobile learning media In your opinion: • What are limitations and weaknesses of ML (in contrast to CL)? • What are opportunities and strengths of ML (in contrast to CL)? • What impact does ML have on your learning activities (in contrast to CL)? • How could ML enhance future clinical education and practice?

Table 2. Focus Group Interview Guideline.

Analysis

Open-ended prompts were offered to gain insight into the medical students' attitude and experiences with digital learning media in order to guide the interview and minimalize influencing the manner in which they would respond.

The focus group interviews were audio- and video recorded and transcribed verbatim with each participant being assigned an anonymous identifier (1-18, randomly assigned) using f4 transcription software (Dresing & Pehl, Marburg, Germany).

For analysis, a preliminary coding scheme based on the grounded theory technique (Glaser, Strauss, 1962) was used, in which codes are drawn from the text and coding involves frequent comparative analysis of the data. The questionnaire served as orientation for coding, and subtopics were identified in an iterative process, which ensured that topics were comparable across groups. The transcriptions were analysed and coded into categories and sub-topics using MAXQDA qualitative analysis software (Verbi, Berlin, Germany). Codes were added or deleted to finalize the coding scheme. An additional researcher reviewed all of the codes independently. Discrepancies in coding were then reviewed and resolved by consensus. Final grouping of the codes

into overall topics was completed by the researcher (JG) as well as selecting illustrative quotations.

4. Results

4.1. Demographic data

„A total of 258 out of 338 (76%) students enrolled in the pharmacology course (winter term 2012/13) at TUM participated in the study. The mean daily participation in the online survey was 79.5 (± 18.2) students (Table S1). Responses of day 1 and 35 were omitted from further analysis due to low participation numbers (29 and 24 students, respectively). The mean age of participants was 23.4 (± 3.5) years. The female:male ratio of participants was 1.77:1 with 165 (64%) female and 93 (36%) male students. Of all students enrolled in the course „general pharmacology", 68% were female and 32% male." (Gutmann et al., 2015). „A total of 316 out of 338 (94%) students participated in the final paper-based survey." (Gutmann et al., 2015). Out of the total study cohort there were 19 students identified and considered as high frequency users, which means they answered the daily online- survey more than 50% of the time. 11 of these students voluntarily took part in the semi-structured telephone interviews. The focus group cohort consisting of 3 groups with 18 participants included two-thirds female (12) and 6 male students with an average age of 23.3± 2.8 years. „In comparison, 65% of all medical students and 68% of first year medical students in Germany in 2013 were female ("Statistical Yearbook 2014," 2014)." (Gutmann et al., 2015). 11 (61%) of these students reported regular use of Smartphones, mainly for communication, internet-research and time- management. Focus groups reflected a cross- section of the students involved in the study with regards to most prevalent demographic data at TUM such as mobile device ownership, age and gender.

4.1.1. Quantitative data

Use of digital versus non-digital media

„To gain insights into learning resource use by undergraduate medical students in pharmacology, we analysed the overall employment of digital and non-digital learning media over the whole course period. Digital learning media were defined as electronic means of communication that deliver learning content via the internet and included smartphone applications (web-based or native apps), lecture slides (at TUM downloadable as Portable Document Format (PDF) files via the campus management system), online exam questions, internet search, podcasts, e-books and e-learning cases. Non-digital learning media were defined as paper-based resources and included printed textbooks (>300 or <300 pages, respectively) and personal notes by the students. All learning resources surveyed were available to students at TUM. Cumulative analysis of the 1st, 2nd and 3rd most used learning media revealed that study participants predominantly employed digital over non-digital learning resources (69 ± 7% vs. 31 ± 7%; $p < 0.01$; Figure 2A). Of note, no significant difference in the use of digital and non-digital media between male and female study participants was observed (Figure 2B). “(Gutmann et al., 2015).

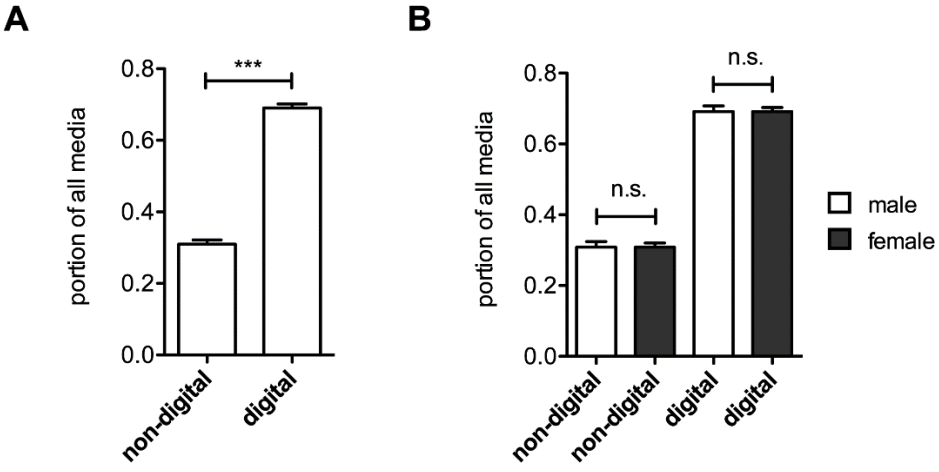

Figure 2. Use of digital and non-digital learning resources by students. (Gutmann et al., 2015)

A. Cumulative results of all study participants. B. Cumulative results of male and female students, n = 258, *** $p < 0.01$; n.s. = non- significant.

Quantitative ranking of learning media

„To delineate the quantitative significance of individual media for learning, we investigated the number of votes for each medium in relation to all responses. Figure 3 depicts the media ranking based on mean use in percent. The most utilized learning resources were lecture slides (26.8 ± 3.0%), apps (22.0 ± 3.7%) and personal notes (15.5 ± 2.7%), followed by textbooks > 300 pages (10.6 ± 3.3%), internet search (7.9 ± 1.6%) and e-learning cases (7.6 ± 3.0%). Other learning resources were only rarely used by the students, e.g. textbooks < 300 pages (4.8 ± 2.2%), e-books (0.7 ± 0.7%) or podcasts (0.3 ± 0.5%).

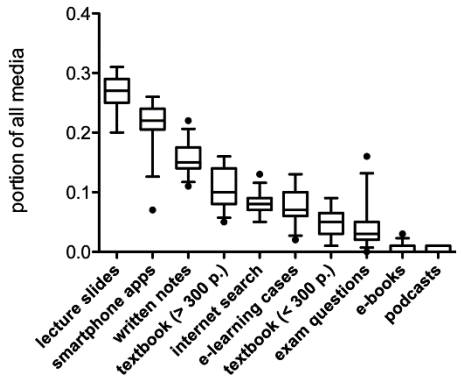

Figure 3. Quantitative ranking of learning resources during the course module. (Gutmann et al., 2015)

Box plots showing median, first and third quartile with whiskers representing the 5% and 95 % percentile. Statistical outliers are shown as black dots. n = 258.

Results

Investigation of media use during the teaching period revealed similar results, while ranking of learning media differed slightly in the self-study period" (Gutmann et al., 2015). (Figure 4). „Collectively, these data reveal a predominant use of digital learning resources by undergraduate medical students in pharmacology, and suggest that the relevance of individual learning resources varied between teaching and self-study periods of the same course module." (Gutmann et al., 2015).

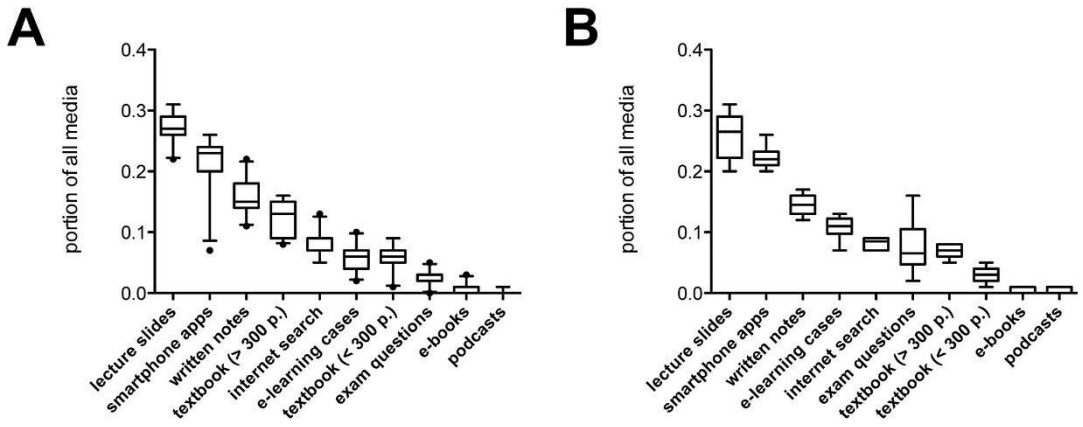

Figure 4. Quantitative ranking of learning resources in different course periods. (Gutmann et al., 2015)

A. Teaching period. B. Self-study period. Box plots showing median, first and third quartile with whiskers representing the 5% and 95 % percentile. Statistical outliers are shown as black dots. n = 258.

Daily media use and comparison of teaching vs. self-study period

„To monitor dynamic patterns of learning media use within the course module, we tracked the employment of individual media types at day-by-day resolution. As shown in Figure 5, the application of most learning media types was relatively constant, while some media exhibited noticeable differences during the teaching module.

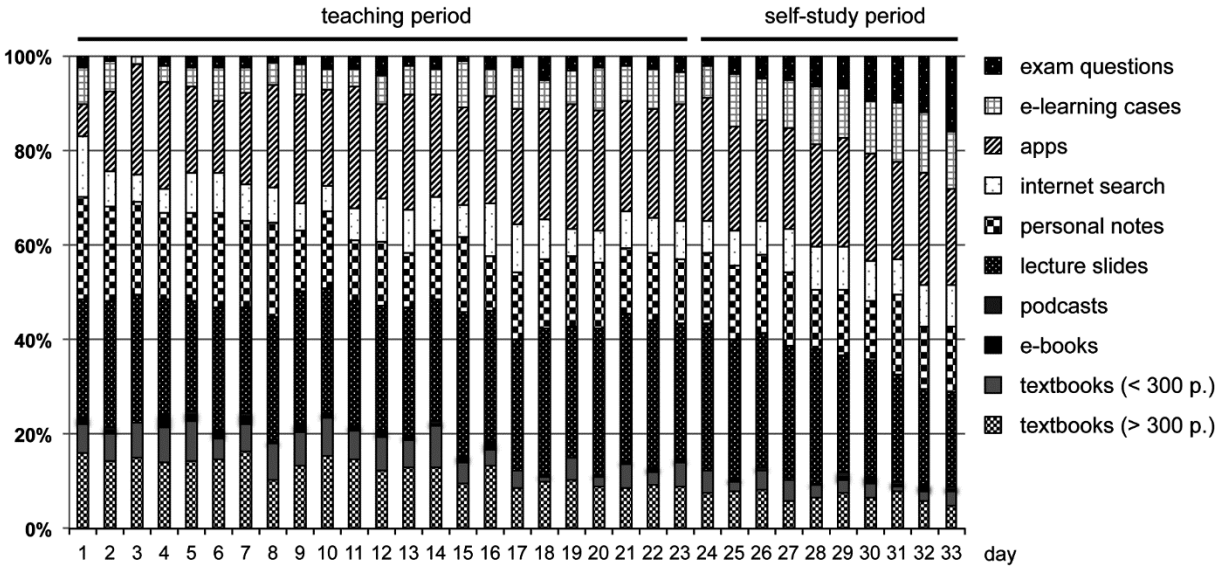

Figure 5. Analysis of daily media use. (Gutmann et al., 2015)

The stacked bars are depicting the ratio of each learning resources in relation to all learning media used per day in percent. Day 1-23 was teaching period, day 24-33 self-study period. The mean daily response rate in the online survey was 79.5 (± 18.2) students.

We performed comparative statistics to assess potential changes for individual learning resources between teaching (day 1-25) and self-study periods (day 26-35) (Figure 6). Of the non-digital learning media, only textbooks (> 300 p) and textbooks (< 300 p.) were used significantly less in the self-study period when compared to the teaching period (-57%; $P < 0.0001$ and -53%; $p < 0.01$, respectively). Of the digital learning media, the use of exam questions (+176%; $p < 0.01$) and e-learning cases (+334%; $p < 0.01$) markedly increased in the self-study period. No significant changes were observed for other learning media. “(Gutmann et al., 2015).

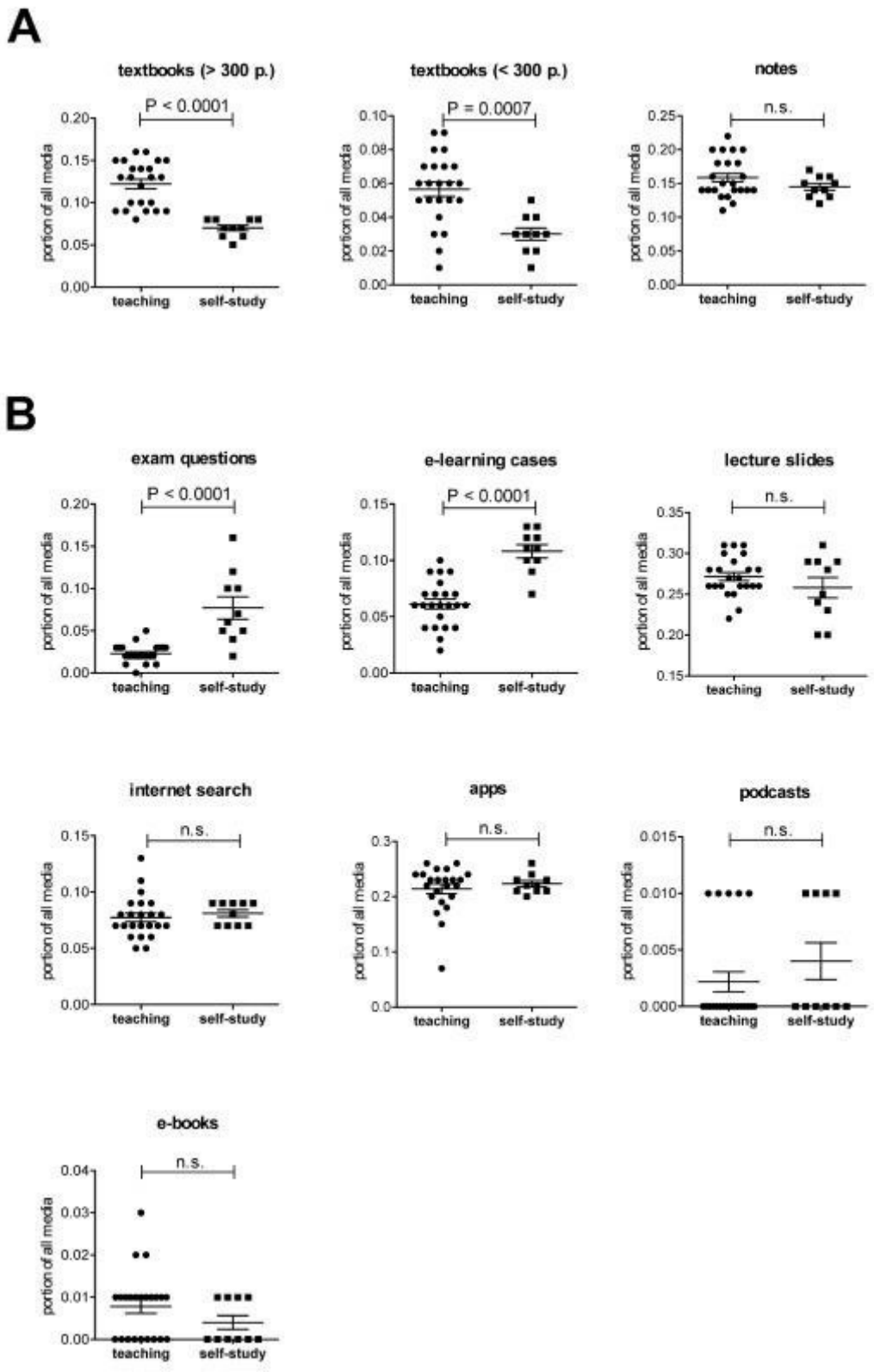

Figure 6. Comparison of learning media use in teaching vs. self-study periods. (Gutmann et al., 2015)

Dot plot charts of most used learning media per day. Each data point represents the mean cumulative responses for a learning medium of a single day in relation to all media in percent. The mean daily participation rate in the online survey was 79.5 (± 18.2).

Online survey about frequency of use of digital learning media

To gain a preliminary insight into frequency of use of digital learning media for the purpose of medical training, an online survey was performed prior to the focus groups. 15 out of 18 focus group participants took part in the questionnaire. Figure 7 depicts the distribution of frequency of the digital media use. The graph shows the portion of student agreement on frequency of use in % for each learning media. 93% of the participants have been using wikis often or sometimes, followed by 80 % students who used social media and fora. Media sharing was used by 66% of the students often or sometimes. Video podcasts (80%) have been used more often than audio podcasts (40%) and e-learning cases (40%), whereas Apps and Blogs were used least (only 40 % of the students used apps and 20% used blogs often or sometimes).

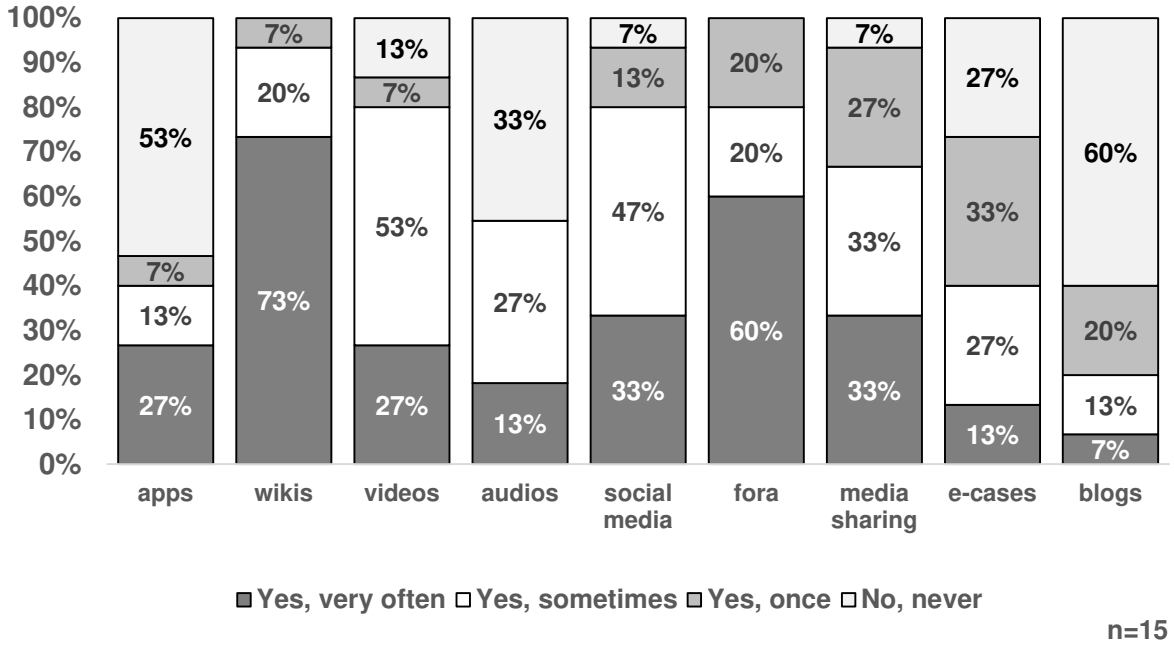

Figure 7. Distribution of frequent use of digital media for medical studies.

4.1.2. Qualitative analysis

Interviews

„To expand, cross-check and further understand data obtained from the quantitative analysis, semi-structured telephone interviews were conducted with a sub-cohort of survey participants." (Gutmann et al., 2015). Representative statements are cited in Table 3. „The interview participants endorsed central findings of the quantitative study, foremost the different usage patterns of textbooks, exam questions and e-learning cases in teaching vs. self-study periods. When asked for potential reasons for the decline of textbook use during the progression of the pharmacology course, a common theme that emerged from the interviews was the perceived benefit of textbooks for systematic knowledge acquisition of new topics, which is particularly required in the initial course phase. In contrast, exam questions and e-learning cases were seen as best suited for knowledge consolidation, proof-checking" (Gutmann et al., 2015). of already learned facts „and transfer to clinical scenarios. Inquiring about the high but constant use of apps in both teaching and self-study periods, interview participants most often mentioned quick data access and concise presentation of information as the key advantages of these media. Finally, lecture slides by the educators were regarded as important framework for learning and guidance for (exam) relevant information." (Gutmann et al., 2015).

Course Period	Media	Code	Representative Statements
Teaching period	Non-digital media	Knowledge acquisition	*"I use books at the beginning [of the course] in order to get a detailed overview of the entire topic."*
Self-study period	Digital media	Repetition	*"At the end [of the course] I like to learn with quizzes or [e-learning] cases because it is a playful repetition."* *"The information [of the app] was very condensed, very useful for repetition."*
		Exam relevance	*"I predominantly learned with the lecture slides because those contained all the relevant information I needed for the exam."*
Overall time		Look-up	*"I liked apps because I could look up information quickly on the go."*

Table 3. Qualitative results of semi-structured interviews (n=11). (Gutmann et al., 2015)

Focus groups

Three focus group sessions were conducted in order to elicit students' thoughts and opinions on digital and non-digital learning media in medical education on behalf of the pharmacology course.

Digital learning media which can be accessed via mobile technology such as smartphones and tablet PCs, included on the one hand on institutional provided media such as interactive e- learning cases, quizzes, apps, forums as well as downloadable lecture slides, lecture videos or podcasts. On the other hand, it implied online media available for public included wikis, social platforms such as Facebook, and media sharing tools such as Skype or Dropbox. On the contrary, paper-based textbooks and personal written notes were considered as conventional learning media or non-digital learning media.

Results

In the following section, representative interview quotations are presented to highlight particular topics identified.

In accordance with the interview guideline five distinct topics emerged during focus group discussions:

1. Potentials of digital learning media and non-digital learning media
2. Limitations of digital learning media and non-digital learning media
3. Perceived impact of certain learning media for medical education
4. Possible use of mobile learning media in clinical education
5. Outlook on learning media in medical education

Potentials of digital learning media and non-digital learning media

Potentials of digital learning media

Due to the handiness of modern mobile end-devices digital learning media becomes accessible at any place and at any time and is therefore considered as mobile learning media. Focus group participants identified five major advantages of learning via mobile technologies in particular, namely:

- Superior technology
- Portability and handiness
- Flexibility and efficient time management
- Ubiquity: on-the-go and just-in-time
- Unlimited and up-to-date information

Based upon the pervasive ownership of mobile end-devices in recent times and increasingly digitalization of society, students felt, that it is just a matter of time until mobile end-devices are likely to become wide spread among medical students and therefore are assumed to be an integral part of medical education as well.

"I think it is the technology of the future which will prove its superiority, because there are just too many advantages."

Most students agreed that especially the handiness and low weight of those small mobile end-devices make usage more comfortable than with heavy volume textbooks. This portability of not only the device itself but also consequently the multiple available content on the device, offers the chance of convenient mobile use and easy access to information.

"It is very handy, so you can always carry it around. Even the smallest book is bigger and heavier than a Smartphone."

"I like to repeat while on-the-go. Since screens are now sufficiently large enough, it poses no problem anymore."

Since the devices are so handy and easy to carry around, some students tended to make valuable use of their idle times by mobile learning. This flexibility provided learning which was considered "efficient" for the reason of improved time-management by making use of wasted time, and being able to access information even in spare moments.

"If the drive takes some time, I like to learn instead of staring into space and wasting my time."

Some students mentioned that mobile learning offered the only way to incorporate sports during study periods.

"When running two hours on the treadmill I enjoyed listening to podcasts. This way I was able to use time even more effective."

They believed that checking information on mobile end-devices is a valuable and time saving process, especially for studying more productively.

As one assumes through the very nature of the flexible use of mobile-end-devices, using it 'on the go' and 'just-in-time', irrespective of time and location, was a recurrent positive statement.

> *"I think it is awesome! You can easily look up something [on your Smartphone] with just one single finger, even in overcrowded subways. In contrast you probably would not be able to open a book [in this crowd]."*

One key advantage of being able to learn "on-the-go" is the possibility to instantly and spontaneously access any possible information worldwide with up-to-date content.

> *"The huge potential of this small device is that you have unlimited access to all the knowledge of the entire world… [In contrast] you have to take a bunch of books for different disciplines like urology, gynaecology etc."*

This is considered as fairly useful since the constant and rapid development of new guidelines or drug dosages in medicine was considered overwhelming. Medical-books in contrast are regarded as mostly already outdated at the point of publication. Internet enabled mobile end-devices therefore are considered as beneficial tools because they can be used as an immediate source for checking current information.

> *"You always get the most up-to-date information in case of some new releases… Books are not up-to-date, especially in medicine which is a rapidly evolving topic."*

Results

Potentials of non-digital learning media

Besides these mentioned potentials of digital learning media which evolve through the use of mobile end-devices, non-digital learning media such as textbooks are still valued. During focus groups three main reasons emerged:

- Personal preference
- Possibility of editing and highlighting
- Trustworthiness of source

A couple of those “conservative” students would rather read a book in traditional print format than digital. Some students prefer print media without any further reason, others because they like feeling the book physically in their hands.

> *“I would never exchange those [apps] for my books.”*

Those “conservative” learners also like being able to reference a book easily with tabs, marks, underlines, or highlights and to take notes beside the text.

> *“I prefer to study with a book or written notes, in which I can mark and scribble in…”*

Few students who consider themselves as “conservative” learners prefer to use printed books, because they consider books as more trustworthy and accurate learning media than sources on the internet based on the assumption of a listed bibliography and the fact that books are usually reviewed prior to publication.

> *” I have a high level of confidence in [the content of] books…”*

Limitations of digital learning media and non-digital learning media

Limitations of digital learning media

Although there are several potentials of the use of digital learning content on mobile technology for medical education, focus groups revealed that there still remain challenges that need to be overcome, regarding:

External factor	Internal factors
• Device	• Overreliance, superficial learning and addiction
• Internet	• Imbalance of study- and leisure-time
• Apps	• Distractive learning environment
• Ownership	• Doubtful trustworthiness
• Costs	

Limitations of digital learning media due to external factors

External factors mentioned by the students included technical limitations, mainly screen size and insufficient or costly internet access. Additional a lack of supply of high- quality learning- content such as in apps and fairly high costs of mobile devices were felt to be a challenge. Mobile devices, especially Smartphones have a rather small screen size which can not only strain the eyes of the students who try to learn with it for a long period but can also display only a small amount of information.

> *"I cannot learn with such a tiny thing, where I have to squint my eyes to see anything."*

Also, those mobile end-devices are dependent on reliable Internet-access, which is not always provided, or limited of speed, even at the universities.

> *"I think it is not useful because you do not have sufficient Internet connection all-around."*

Results

Although there are already hundreds of medical apps provided, students believe that there are not enough quality and elaborated apps in German language and they mentioned that a lot of those applications still need refinement especially considering ease of use and content presentation.

> *"I do learn with my Smartphone although the supply of applications is often either so far not existing or ill-conceived."*

Another flaw mentioned was the confusing oversupply of applications in the app-stores without any recommendation of professional apps by the faculties. Students were concerned about the quality of the provided app content due to the lack of reliable references and mentioned that they could use it more effectively if the faculty would recommend quality proofed applications for their students.

> *"I prefer learning with quality certificated content, for example provided by the university."*

There was consent on the fact that other students should not be disadvantaged regarding the provided information of faculty intern mobile applications. Teaching content should not depend on certain kind of end-devices since although there is a high ownership, still not all students have access to mobile end-devices or own them.

> *"They should not take smartphone ownership as a given and imply that all students should have and use it."*

Additional cost is a great disadvantage of mobile learning, not only that mobile end-devices do cost a certain amount of money, but in order to be able to use these devices efficiently you need to have access to internet which means additional monthly data charges by mobile providers.

> *"It is unfair because not everyone is able to afford a tablet or Smartphone."*

Limitations of digital learning media due to internal factors

Additionally, there were several internal factors emphasized by the students that pose certain limitations to the use of digital learning media.

Being able to offload mental functions to digital devices and being able to look up everything at the point of need, few students are concerned that the use of Smartphones in education may result in an over-reliance. They fear that substituting your Smartphone for your brain might lead to limited internalized knowledge and resulting stultification.

> *"Knowledge in your brain versus knowledge in the app."*

Students worry that they might lose track of the content as a whole by just looking up fractional key words or topics, which could result in superficial and incoherent knowledge.

> *"I believe that some people think less on their own because they can just look it up."*

A couple students also feared the possible risk of addiction to those devices and constant information access. Some students valued for example in particular the time spent in subways on the way as quality leisure time, where they can relax and do not have to be engaged in studying since medicine is a very knowledge-intensive subject.

> *"Since medicine is a quite laborious study, I must admit that I really enjoy relaxing while on the go. Just having those 10 minutes on the subway to get some rest from it."*

For some students, the fact that via mobile end-devices you are always connected to the world, it is difficult to rest or just keep away from permanently looking up

information, even in leisure times and designating a clear delineation between study life and private life.

> *"It is hard trying to out-balance study and leisure time."*

Another limiting aspect is the often distractive learning environment, meaning in particular noise and overcrowdings, while on the go with the consequence of lacking concentration.

> *"Learning on-the-go is difficult. For example, taking the subway is very distracting."*

Students not only worry about being distracted by the real environment. Also the virtual environment on those end-devices for example social media such as Facebook pose the potential risk of unfocused "inefficient" learning.

> *"Sometimes discussions [online] are getting off-focused because people start bragging or asking about irrelevant different topics."*

Due to the vastness of sources on the World Wide Web there is also mistrust in the reliability of data derived from variable web pages among the students.

> *"You have to watch out for reliable internet sources and sometimes just hope that it is right."*

Limitations of non-digital learning media

Some limitations of non-digital learning media directly result from the potentials of mobile learning media like lack of comfortability and limited portability due to size and weight as well as the problem of already outdated content upon release. There are also some additional limitations which students came up with during focus group sessions:

- First edition errors
- Laborious search
- Extensive elaboration of content

With the release of new medical books comes the problem of not only already out-dated information, but also various errors which will be corrected only in future editions. Students often have to use errata along with the books, which makes studying very tiresome.

> *"If it is the first edition of a book I rather trust the internet on information, since usually there are too many mistakes in those books."*

Due to the very nature of a book, one has to use the table of contents to find information in the book, which some students find too ineffective and therefore prefer e-books or other digital content because looking up key topics is much easier and quicker.

> *"With digital learning media I can quickly search for something even in a 1000-pages document, but with a book I would have to look in the table of contents just to get the wrong page and search over again…"*

Depending on the format of a book, some books give quite detailed information on certain topics that might not be of primary interest, especially during exam preparation and therefore some students fear to get off-focused and lost in detail.

> *"It happens quite often that if I use heavy volume books I tend to get lost in detail."*

Perceived impact of certain learning media for medical education

Digital learning media

Mobile learning introduces a new type of studying, which is different in many ways from the typical non-digital tasks such as making notes and reading from a textbook. These digital learning media that can be also used mobile included in particular apps and

learning cases. Quizzes that test certain learning content in order to individually proof check or repeat already learned knowledge as well as lecture slides are highly valued especially for exam preparation.

The most mentioned effects of these learning media on their studies which students noticed were:

- Variety
- Diverse approaches
- Interactivity
- Fun and motivation
- Addressing multiple senses
- Individuality
- Efficient learning through online look-up
- Proof-checking of acquired facts
- Knowledge consolidation through repetition
- Peer-to-peer interaction via social media platforms
- Peer-to-teacher interaction via social media platforms
- Exam preparation

The wide variety of learning possibilities via digital devices, most notably mobile end-devices, offers diverse approaches to learning content, which enriches the learning process.

> *"I like variety while learning. Not just reading all the time."*

> *"In pharma after I learned with a book, I liked to repeat the topics with the pharma-cases or the quizzes at the end of the day; simply changing medium."*

Through more interactive and individual access to information m- learning seems to provide internal motivation to some students. Therefore, participants feel that using m-learning media adds to more fun, and increased motivation, interest and engagement.

> *"This way you are having fun while learning. I do not enjoy reading a book ten hours long. It is a refreshing and diverse way of learning."*

Results

The capacity to have different types of learning media available, including not only visuals, audio podcasts, but also animations, interactions and game based learning, provides diverse chances of imparting and approaching new learning content, by encompassing and blending multiple senses.

> *"I like graphs to learn from with animated arrows for receptors or point of action and interactive linkages for more detailed information."*

> *"You can address multiple senses. A book just cannot offer this chance of cross-linking several senses."*

Students believe that the individual arrangement of these various learning strategies as well as time-management through the independency of time and location might enhance memory and allow them to find their personal learning path within their individual learning context.

> *"You can individually schedule when you want to listen e.g. to podcasts; when you are highly motivated and focused."*

Not only multimedia interactive features are valued as beneficial but also the direct impact on learning activities such as more simplified access to different resources via mobile internet-enabled end-devices. Wikipedia is a highly used and valued internet source by the students.

> *"I think that you are able to learn more efficient because you don't have to look up things in five different books. I simply take my smartphone or tablet and enter it on Wikipedia and then I know it right away."*

Since long-term memorizing of the extensive amount of medical knowledge is felt to be a great challenge, most students also favored the chance of consolidating already

pre-acquired knowledge in small units via repetition, on-the-go check-up, or simply testing knowledge by doing online quizzes.

> *"I liked to proof-check my knowledge with quizzes, to figure out whether I actually learned and remembered anything in pharma."*

They therefore considered mobile learning as efficient for their further studies. Being able to constantly look up information "on-demand" resembles a unique way of knowledge acquisition, which is hardly possible to achieve with single use of print media. They also valued mobile media such as apps especially as a suitable tool for learning hard facts or memorizing lists by heart.

> *"…The chance to practice; simply repeating certain topics."*

The virtual learning environment also fosters peer-to-peer interaction as well as facilitation of intensified student teacher interaction via specially designed forums for communication, questions, feedback and inter-exchange of supporting learning material.

> *"Web forums are of great importance to get feedback from fellow students; to know that others have the same comprehension problems."*

Facebook was especially mentioned by the students and despite certain limitations such as privacy concerns and missing moderation of discussions, it was highly valued because of immediate support, organizational information provided, document sharing and collective peer knowledge.

> *"If you need any information, there is certainly someone who can provide it."*

Not only social media platforms offer this chance but also faculty intern fora can be of great value for both educators and students to foster peer-to-teacher interaction.

"Some lecturers are unapproachable. There is no way to directly contacting them. This I liked in pharma. With this forum we had the chance to ask questions and get the answer right away."

When it comes to exam preparation in particular, lecture slides provided by the faculty are highly valued by the students.

"Lecture slides are indispensable [especially for exam preparation]."

Non-digital learning media

Despite all the advantages of mobile learning, there still remain students who consider themselves as non-digital learners, and who prefer to study with more traditional learning media, books above all. Therefore, focus groups revealed three aspects that occur when learning with non-digital learning media.

- Coherent learning
- Understanding of complex context
- Stationary setting

Studying with a book seems to be the favoured choice when it comes to "learning properly". Most students define the term "learning properly" as acquisition of new knowledge, gaining a deeper understanding of a particular topic and learning coherently in context.

"I am simply someone who just likes to study with a book, reading coherently."

"For proper comprehension I need to read a written-out text in my heavy-volume books and not just listed facts like in an app."

Additionally, they prefer stationary long lasting learning time-periods at a desk at home or in the library. In contrast few students even regard “fractional learning” with an app as improperly and inefficient.

> *“I would not memorize that much, as if I sit down at home in silence with my written notes or a book trying to understand the context.”*

Possible use of mobile learning media in clinical education

Chances of mobile media use in clinical education

Three distinct topics emerged considering possible chances of mobile learning media regarding clinical practice.

- Practicing clinical pictures
- Quick reference
- Digitalization of patient data

Due to mobile accessibility some digital learning media, in particular learning cases and apps are especially suitable for bedside clinical medical teaching in order to convey comprehensive knowledge to the students. On the one hand, understanding complex clinical pictures in context and practicing how and when to use certain medication can be easily achieved via learning cases.

> *“It is very useful because you get to know certain clinical pictures and when to use which drug by doing these cases.”*

Also on the other hand, apps for drug references including interactions, dosage and adverse effects as well as active agent and quick overview of most common diseases and evidence based treatment could help students in their clinical routine.

> *“You can look up up-to-date pharmacological information, especially new drug interactions, treatment in pregnancy or antidotes for intoxication. “*

Additionally, students imagined that the overall digitalization of patient data could lead to more sufficient patient care as well as treatment.

> *"It could be very helpful to have instant access to patient's laboratory values or imaging finding especially during ward rounds. "*

Challenges of mobile media use in clinical education

Even though, there are certain potentials of mobile media in clinical education, students mentioned in particular two challenges that they imagine could interfere in clinical practice.

- Patient data-hacking
- Disturbed patient-doctor relationship

Students fear that there could be a patient data security breach, when storing and working with patient data digitally on mobile devices.

> *"I fear that patient data could be hacked. "*

Also, students argue that that the use of mobile phones during clinical practice could lead to patient insecurity.

> *"Using a smartphone in front of the patient could lead to mistrust and unease. "*

Since medical undergraduate students do not have sufficient clinical experience, the use of digital learning media in practice can only be assumed.

Outlook on learning media in medical education

Although some students strongly rely on books or on web-based information, all students tended to double-check with other media in case of uncertain information, largely depending on the topic of interest.

"I try to combine several resources…it depends on the subject and resources whether I rather trust in books or web-based-resources."

Some students made use of their Smartphones or tablet- PCs not only while on-the-go but also continued to use it at home as an additional tool to quickly look up key facts, while studying with a book.

"I simply combine it. For example, I study with a book and I have the tablet or Smartphone right next to me in order to look up anything I don't know by asking Wikipedia."

Students figured that the generation gap complicates further developments in education and agreed upon that in order to improve medical education, there needs to be intensified communication between digital immigrant educators and digital native students about views and attitudes regarding modernizing learning media.

"I think lecturers could become a little more modern in terms of education. "

Despite the personal media preference, the idea of offering the opportunity of accessing learning content via mobile devices to all students, who can then decide for their own whether and how they want to use these additional ways of learning with mobile devices, was shared by all students.

"It just depends on your personal learning style. Most important is that you have the chance to choose from different learning media. It is always about having a choice."

5. Discussion

„[T]here is a paucity of information about the quantitative and qualitative use of learning resources by the current student generation in higher education." (Gutmann et al., 2015). In this study we provide a comprehensive assessment of learning media use by undergraduate medical students in a genuine educational setting. „Using a prospective mixed-method design with daily online surveys and final semi-structured interviews" (Gutmann et al., 2015). as well as in depth focus group discussions, „we demonstrate a preponderance of digital resources for learning by both male and female students in pharmacology. We show that students employ a broad spectrum of learning media" (Gutmann et al., 2015)., of which digital learning media were predominantly used.

5.1. High ownership of digital mobile devices

In a previously published study we reported that approximately 80% of the students at TUM own a mobile internet-enabled end-device (Kühbeck et al., 2014). This finding is in line with other studies that reported not only high ownerships of mobile computing devices, but also active use of medical related applications to enhance their learning (Koehler, 2012; Robinson et al., 2013; Wallace et al., 2012). In accordance with current literature (Davies et al., 2012; Wallace et al., 2012) this study illustrates that especially convenience through portability of the devices and the resulting easy and instant access of world-wide op-to-date knowledge were major inherent benefits of these devices. This high ownership of digital mobile devices is an important precondition for the overall findings of this study.

5.2. Potentials of mobile learning media

This study supports the findings of Wallace et al. (Wallace et al., 2012) and Davies et al. (Davies et al., 2012), who both identified similar topics within their focus group

discussions regarding the potentials associated with the use of mobile computing devices. In accordance with current literature our study illustrates that especially the convenience through portability of the devices and the resulting easy and instant access of worldwide up-to-date knowledge, were major benefits, which can all be used to incorporate these media in medical training.

5.3. Predominant use of digital learning media

„Our results revealed the predominant use of digital learning resources by 3rd year undergraduate medical students enrolled in a pharmacology course in Germany. This finding is in accordance with studies conducted with US medical students on internal medicine clerkships that reported internet databases (e.g. Up-to-date ®) as a major information source (Cooper & Elnicki, 2011; Leff & Harper, 2006; Peterson et al., 2004). In contrast, a focus group study with UK medical students after their first primary care attachment found non-digital media (notably textbooks) as the medium of choice for personal study (Baudains et al., 2013). This discrepancy may in part be explained by the heterogeneity of students with regard to the use and preference of digital learning sources and devices (Ellaway et al., 2014; Lust et al., 2011), or a non-representative study participants selection for which qualitative studies with smaller participant numbers (e.g. focus groups) are particularly prone (Patton, 1990).” (Gutmann et al., 2015).

5.4. The importance of applications in pharmacology

„A surprising observation of our study was the importance of apps, ranking second of all learning media. Apps are applications optimized for mobile internet-enabled devices (smartphones or tablet-PCs), but are increasingly compatible to a broader range of computing devices (e.g. as web-based apps). We previously reported that approximately 80% of our students at TUM own a mobile internet-enabled device

(Kühbeck et al., 2014), which is in agreement with recent studies on smartphone ownership amongst college students in the UK (Payne et al., 2012; Robinson et al., 2013). It was reported that the majority of students have a positive attitude towards the use of these technologies for educational purposes (Davies et al., 2012; Wallace et al., 2012). However, as emphasized by Nguyen (Nguyen et al., 2015), the availability of high quality apps for learning and its curricular integration is still in its infancy. Moreover, several studies have reported a reluctance of many educators to recommend or use these new educational tools (Harley et al., 2006). In pharmacology, a number of well-developed apps exist (e.g. drug repositories), which may explain the frequent use of apps in our study cohort. It is tempting to speculate that current undergraduate students are likely to embrace apps as a major medium for learning, if available in good quality and fitted to their curricular contents." (Gutmann et al., 2015).

5.5. Limitations of digital learning media

One should be aware of some limitations of mobile learning media. Minor challenging topics that occurred, regarding screen size, technical and functional aspects of the devices and apps, as well as insufficient internet connection and problems that occurred while on-the-go, were believed to improve over time, as technology will develop fast over the next years. But, as Wallace et al. (Wallace et al., 2012) have already observed, some students in our study were also very unsure about certain aspects of mobile media in learning. Concerns mentioned primarily focused on the impact of outsourcing memory to the internet. Some students feared that being able to constantly look up any information needed could lead to less internalized and coherent knowledge resulting in stultification at the worst. Sparrow et al. (Sparrow et al., 2011) summarized findings of four studies who showed that when students were expected to have future access to information, they have lower recall-rates of the information itself.

These findings should carefully be kept in mind, when thinking about implementation of mobile learning media into medical education. Additionally, participants highlighted the fact that there should be no discrimination of any students who either cannot afford or simply do not want do use a mobile end-devices. They suggested that supporting learning media should always be independent of media choice and therefore be accessible for all students.

5.6. Diminishing but still valuable use of non-digital learning media

„Our survey data revealed the use of a broad spectrum of learning resources by undergraduate medical students in pharmacology. Textbooks, long regarded as the main medium for students` learning (Kozma, 1991), accounted only for approx. 15% of most used learning resources in our study. This range is consistent with a recent study using self-reporting diaries in a cohort of UK medical students that found textbooks to account for approx. 25% of learning media (Brennan et al., 2014), suggesting that the role of “traditional” learning resources in higher education is in a process of rapid transformation. Moreover, the efforts to adapt textbooks to the digital world, e.g. as e-books appears to be of limited success. In our study, we found e-books only rarely used by students despite the fact that most textbooks used at our institution are available in digital formats. These results underscore earlier findings by Woody et al. (Woody et al., 2010) who showed that the majority of students preferred printed over electronic textbooks irrespective of gender, computer use or technical affinity.” (Gutmann et al., 2015).

Nevertheless, conventional learning media such as printed textbooks, are still favoured, in particular when it comes to contextual learning of new content or because of personal learning style preference. Few valued the trustworthiness of books and tend to rather rely on textbook resources compared to web-based resources. Baudains

et al. (Baudains et al., 2013) were also able to show within their focus groups that printed textbooks are not out-fashioned but still have certain advantages. One major theme was the experience of physically feeling the paper of a printed textbook.

5.7. No gender difference in media use

„An important finding of our study was that preference of digital and non-digital learning resources did not differ between male and female students. Imhof and co—workers assessed the computer use in a cohort of German university students and reported no gender differences, neither with regard to time spent on task nor with preferred activities at the computer (Imhof et al., 2007). These and our findings contrast earlier studies that reported significant higher computer and internet use by male students (Broos, 2005; Sánchez-Franco, 2006).” (Gutmann et al., 2015).

5.8. Dynamic pattern of media use and reasons behind this

„An interesting outcome of our study is the dynamic pattern of learning media use within a self-contained teaching module. When comparing teaching vs. pre-exam self-study periods, textbooks (> 300 p. and < 300 p.) were used significantly less (-57% and -53%, respectively) during self-study, while exam questions (+334%) and e-learning cases (+176%) were utilized more. A study by Briscoe et al. reported that both medical students and residents preferred printed over digital media for initial learning, however reasons behind their preferences remained unknown (Briscoe et al., 2006). Our interview results suggest this observation may be due to the perceived benefit of textbooks for systematic knowledge acquisition of new topics.” (Gutmann et al., 2015).

5.9. Supply of learning materials by educators and institutions

„Finally, in spite of the broad use of novel learning media in our study cohort, our quantitative and qualitative analyses demonstrated a key role for learning media provided by educators (e.g. lecture slides or indirectly as written notes)” (Gutmann et

al., 2015)., especially for exam relevant topics. „While the role of the lecturer is likely to change in the future from a provider of information towards a facilitator of learning (Sandars & Morrison, 2007), our results further underscore that today`s students value educators` learning materials as means of guidance. Moreover, as institutions and educators increasingly make materials available online (e.g. via campus management systems or open-source learning platforms), there will be a reduced need to consult traditional learning sources, e.g. textbooks." (Gutmann et al., 2015).

5.10. Effect of mobile learning media on learning activities

The use of mobile end-devices to enhance education has been increasingly evaluated over the last years, suggesting valuable new approaches of ubiquitous access to authentic learning content (Sandars, 2013). This study supports the findings of Wallace et al. (Wallace et al., 2012) and Davies et al. (Davies et al., 2012) about the effect of mobile learning on learning activities. In common with our findings, this study showed that mobile end-devices have the potential to facilitate student learning by providing easy "on-the-go" and "on demand" access to worldwide information, especially for looking up and repeating key facts and making use of wasted time. This offers the chance to create a personal learning context, in which students have the possibility to increase their engagement and motivation to medical related topics by having a variety of creative multimedia tools and resources on the device itself with or without the World Wide Web, enabling the students to choose other and individual ways of learning.

5.11. Broad supply of learning media for all students

Finding a majority of students in our study who feel that mobile learning media are a suitable supplement for their studies, we agree with Arthur Richardson (Richardson, 2002) who defines a learning ecology as an environment in which people can choose from a variety of resources and activities which apply to their individual learning. He

suggests that through e-learning one enables to combine technologies with the variety of resources and support student interaction and learning. Although there are numerous learning style models proposed by many researchers one can agree that there is a huge variety of individual preferred learning styles, which makes it impossible to identify the one preferred learning style or learning media that works for all students (Arp, 2006; Gülbahar & Alper, 2011; Nilsson et al., 2012). Gülbahar and Yildrim (2006) conducted a research based on individual learning differences and concluded that it was necessary to present learners with all possible types of media and material resources, including non-digital media as well as digital learning media (Gülbahar & Yildirim, 2006). The increasing digitalization of society should encourage educators to also adopt to these digital technologies and integrate those into the existing curricula (Dala-Ali et al., 2011; Sandars, 2013) according to students' actual needs and use of devices. In line with other authors (Dala-Ali et al., 2011; Koehler, 2012; Payne et al., 2012; Robinson et al., 2013; Wallace et al., 2012), we believe that learning media via mobile end-devices have the potential to foster individual medical training at university and clinical practice, but have to be carefully introduced and evaluated by teachers and students, in order to increase potentials but also be aware of the limits and possible risks of these learning media. Therefore, we strongly encourage educators of today to develop and implement learning materials and activities as additional educational tools according to the students' needs with the focus on enhancing medical training.

6. Strength and limitations of the study

The main strength of this study is, that it is the first study to give detailed insights into attitudes of medical students in Germany about learning media in medical education. This study focused on mainly first year medical undergraduate students at Technische Universität München, Germany. „While this study adds to our understanding of learning media use in undergraduate medical education, there are limitations inherent to the methods applied in this study. “(Gutmann et al., 2015).

First, regarding the qualitative acquainted data, as the nature of focus groups, discussion and results were dependent on personal reporting and are so subject to recall bias. Additionally, the moderator and the participants themselves may influence the answers of the discussants. However, discussions focused on the issue of evaluation and were standardized (Morgan, 1996). Although we have no reason to assume that our data is influenced in that particularly way, we cannot rule out a possible bias. Data saturation and consistency among focus groups suggest that the findings are valid. Also, telephone interviews „rely on self-report that may not be answered accurately or faithfully. “(Gutmann et al., 2015).

Second, regarding the quantitative data, „we obtained (…) data on learning media use by an online questionnaire linked to an online learning platform used at TUM. This may have led to a selection bias for students with higher affinity for digital technologies. To estimate the potential impact of this bias, we conducted an additional paper-based survey with all course participants. The vast majority (96%) of students stated that they have regularly accessed the online platform during the course period, thus arguing against a predominant use by a non-representative sub-cohort.

Finally, our study cohort consisted of 338 undergraduate medical students enrolled in a basic pharmacology course at a single German medical faculty. While the

demographic characteristics of our study cohort was representative for German medical schools, females were slightly underrepresented in the online survey when compared to all course participants (64% vs. 68%), which might have affected study outcomes. In addition, media use and usage patterns may differ for students of other disciplines, institutions or academic levels and is likely dependent on materials provided or recommended by the faculty. The present study is therefore exploratory in nature and serves as basis for future multi-centre confirmatory studies with larger cohort sizes." (Gutmann et al., 2015). Assuming a relevant difference considering the use and acceptance of mobile learning media between digital native students and digital immigrant teachers, follow up studies need to be done, to proof this hypothesis.

7. Conclusion

„To our knowledge, this is the first prospective cohort study of daily learning media use in medical education, regarding pharmacology. Both quantitative and qualitative data revealed a high prevalence and acceptance of digital learning media" (Gutmann et al., 2015)., in particular mobile learning media such as smartphone applications. This positive attitude is mainly due to the fact that mobile internet enabled devices are widely available and digital access to unlimited up-to-date information is now possible irrespective of time, location and context. However, non-digital learning media such as textbooks remain important used learning media, emphasising the individual learning style preferences of today students. Additionally, learning media provided by the educator, regardless of the kind of learning media, remain a key source of information and guidance, especially for exam preparation. We thus conclude that "digital natives" are open to novel learning resources which can be e.g. accessed by mobile devices such as smartphones.

This study adds valuable insights into students' attitude, perception and use of learning media in medical education which might be of interest to other medical faculties in order to assist developing student-focused approaches for improving medical curricula. We postulate that the lessons from this data are transferable and that there is considerable relevance for modernizing curricula at other medical institutions worldwide.

„Further studies are needed to investigate what kind of learning media (or combination of thereof) are associated with the best learning outcome in the current cohort of undergraduate students. In addition, further work needs to be done to examine cross-country differences in availability, use or development of digital resources in higher education. This will likely have important implications for the implementation of new

learning media and technologies in academic programs and educational institutions. These research questions will become more complex with the fast pace of technological change and the progression of today's students to the educators of tomorrow." (Gutmann et al., 2015).

References

2 Billion Consumers Worldwide to Get Smart(phones) by 2016. (2014). Retrieved from http://www.emarketer.com/Article/2-Billion-Consumers-Worldwide-Smartphones-by-2016/1011694

Ally, M. (2009). *Mobile learning: transforming the delivery of education and training* (M. Ally Ed.). Edmonton: UBC Press.

Arp, L. (2006). Accommodating diverse learning styles in an online environment. *Reference & User Services Quarterl, 46*(2), 27-32.

Baudains, C., Metters, E., Easton, G., & Booton, P. (2013). What educational resources are medical students using for personal study during primary care attachments? *Educ Prim Care, 24*(5), 340-345.

Baumgart, D. C. (2011). Smartphones in clinical practice, medical education, and research. *Archives of Internal Medicine, 171*(14), 1294-1296. doi:10.1001/archinternmed.2011.320

Bennett, S. (2008). The 'digital natives' debate: A critical review of the evidence. *British Journal of Educational Technology, 39*(5), 775–786. doi:10.1111/j.1467-8535.2007.00793.x.

Brennan, N., Edwards, S., Kelly, N., Miller, A., Harrower, L., & Mattick, K. (2014). Qualified doctor and medical students' use of resources for accessing information: what is used and why? *Health Information & Libraries Journal, 31*(3), 204-214. doi:10.1111/hir.12072

Briscoe, G. W., Fore Arcand, L. G., Lin, T., Johnson, J., Rai, A., & Kollins, K. (2006). Students' and residents' perceptions regarding technology in medical training. *Acad Psychiatry, 30*(6), 470-479. doi:10.1176/appi.ap.30.6.470

Broos, A. (2005). Gender and information and communication technologies (ICT) anxiety: male self-assurance and female hesitation. *Cyberpsychol Behav, 8*(1), 21-31. doi:10.1089/cpb.2005.8.21

Cooper, A. L., & Elnicki, D. M. (2011). Resource utilisation patterns of third-year medical students. *Clin Teach, 8*(1), 43-47. doi:10.1111/j.1743-498X.2010.00393.x

Dala-Ali, B. M., Lloyd, M. A., & Al-Abed, Y. (2011) The uses of the iPhone for surgeons. *The Surgeon, 9*(1), 44-48. doi:10.1016/j.surge.2010.07.014

Davies, B. S., Rafique, J., Vincent, T. R., Fairclough, J., Packer, M. H., Vincent, R., & Haq, I. (2012). Mobile Medical Education (MoMEd) - how mobile information resources contribute to learning for undergraduate clinical students - a mixed methods study. *BMC Medical Education, 12*, 1-1. doi:10.1186/1472-6920-12-1

Ellaway, R. H., Fink, P., Graves, L., & Campbell, A. (2014). Left to their own devices: Medical learners' use of mobile technologies. *Medical Teacher, 36*(2), 130-138. doi:10.3109/0142159X.2013.849800

Frand, J. L. (2000). *The information age mindset: Changes in students and implications for higher education*. Paper presented at the Educause 2000, Nashville, tenessee. https://net.educause.edu/ir/library/pdf/ERM0051.pdf.

Gayeski, D., & Russell, J. D. (2003). Learning unplugged: Using mobile technologies for organizational training and performance improvement. *Performance Improvement, 42*(9), 41-43. doi:10.1002/pfi.4930420910

Gutmann, J., Kühbeck, F., Berberat PO, Fischer MR, Engelhardt, S., Sarikas, A. (2015). *Use of Learning Media by Undergraduate Medical Students in Pharmacology: A Prospective Cohort Study*. PLoS ONE 10(4): e0122624. doi:10.1371/journal.pone.0122624

Gülbahar, Y., & Alper, A. (2011). *Learning Preferences and Learning Styles of Online Adult Learners*: Formatex Research Center.

Gülbahar, Y., & Yildirim, S. (2006). Assessment of Web-Based Courses: A Discussion and Analysis of Learners' Individual Differences and Teaching-Learning Process. *International Journal of Instructional Media, 33*(4), 367-378.

References

Harley, D., Henke, J., Lawrence, S., Miller, I., Perciali, I., & Nasatir, D. (2006). Use and Users of Digital Resources: A Focus on Undergraduate Education in the Humanities and Social Sciences. *Stud High Educ, 94720*(326), 3-19.

Imhof, M., Vollmeyer, R., & Beierlein, C. (2007). Computer use and the gender gap: The issue of access, use, motivation, and performance. *Computers in Human Behavior, 23*(6), 2823-2837. doi:http://dx.doi.org/10.1016/j.chb.2006.05.007

Koehler, N. (2012). Medical Students' Use of and Attitudes Towards Medical Applications. *Journal of Medical Technology in Medicine, 1*(4), 16-21. doi:10.7309/jmtm.73

Kozma, R. B. (1991). Learning with Media. *Review of Educational Research, 61*(2), 179-212. doi:10.3102/00346543061002179.

Kühbeck, F., Engelhardt, S., & Sarikas, A. (2014). OnlineTED.com − a novel web-based audience response system for higher education. A pilot study to evaluate user acceptance. *GMS Zeitschrift für Medizinische Ausbildung, 31*(1), Doc5. doi:10.3205/zma000897

Leff, B., & Harper, G. M. (2006). The reading habbits of medicine clerks at one medical school: frequency, usefulness, and difficulties. *Acad Med, 81*(5), 489-494. doi:10.1097/01.ACM.0000222273.90705.a6

Lust, G., Vandewaetere, M., Ceulemans, E., Elen, J., & Clarebout, G. (2011). Tool-use in a blended undergraduate course: In Search of user profiles. *Comput. Educ., 57*(3), 2135-2144. doi:10.1016/j.compedu.2011.05.010

Maykut, P., & Morehouse, R. (1994). *Beginning Qualitative Research: A Philosophical and Practical Guide.* : The Falmer Press

Mills, J., Bonner, A., & Francis, K. (2006). The Development of Constructivist Grounded Theory. *International Journal of Qualitative Methods, 5*(1).

Morgan, D. L. (1996). Focus Groups. *Annual Review of Sociology, 22*, 129-152.

Nguyen, L., Barton, S. M., & Nguyen, L. T. (2015). iPads in higher education—Hype and hope. *British Journal of Educational Technology, 46*(1), 190-203. doi:10.1111/bjet.12137

Nilsson, M., Östergren, J., Fors, U., Rickenlund, A., Jorfeldt, L., Caidahl, K., & Bolinder, G. (2012). Does individual learning styles influence the choice to use a web-based ECG learning programme in a blended learning setting? *BMC Medical Education, 12*(1), 1-8. doi:10.1186/1472-6920-12-5

Oblinger, D., & Oblinger, J. (2005). *Educating the net-generation*: Educause.

Pander, T., Pinilla, S., Dimitriadis, K., & Fischer, M. R. (2014). The use of Facebook in medical education – A literature review. *GMS Zeitschrift für Medizinische Ausbildung, 31*(3), Doc33. doi:10.3205/zma000925

Patton, M. (1990). Qualitative Evaluation and Research Methods, 169-186. Retrieved from http://legacy.oise.utoronto.ca/research/field-centres/ross/ctl1014/Patton1990.pdf.

Payne, K. F. B., Wharrad, H., & Watts, K. (2012). Smartphone and medical related App use among medical students and junior doctors in the United Kingdom (UK): a regional survey. *BMC Medical Informatics and Decision Making, 12*, 121-121. doi:10.1186/1472-6947-12-121

Peterson, M. W., Rowat, J., Kreiter, C., & Mandel, J. (2004). Medical students' use of information resources: is the digital age dawning? *Acad Med, 79*(1), 89-95.

Prensky, M. (2001). Digital Natives, Digital Immigrants Part 1. *On the Horizon, 9*(5), 1-6. doi:10.1108/10748120110424816

Richardson, A. (2002). *An ecology of learning and the role of e-learning in the learning environment: A Discussion Paper*. Paper presented at the Connecting the Future: Global Summit of Online KnowledgeNetworks.
http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan007791.pdf

Robinson, T., Cronin, T., Ibrahim, H., Jinks, M., Molitor, T., Newman, J., & Shapiro, J. (2013). Smartphone Use and Acceptability Among Clinical Medical Students: A Questionnaire-Based Study. *Journal of Medical Systems, 37*(3), 1-7. doi:10.1007/s10916-013-9936-5

Sánchez-Franco, M. J. (2006). Exploring the influence of gender on the web usage via partial least squares. *Behaviour & Information Technology, 25*(1), 19-36. doi:10.1080/01449290500124536

References

Sandars, J. (2013). Mobile learning (m-learning). In J. A. Dent & R. M. Harden (Eds.), *A Practical Guide for Medical Teachers* (4th ed., pp. 231-236): Churchill Livingstone.

Sandars, J., Homer, M., Pell, G., & Croker, T. (2008). Web 2.0 and social software: the medical student way of e-learning. *Medical Teacher, 30*(3), 308-312. doi:10.1080/01421590701798729

Sandars, J., & Morrison, C. (2007). What is the Net Generation? The challenge for future medical education. *Medical Teacher, 29*(2-3), 85-88. doi:10.1080/01421590601176380

Sharples, M. (2000). The design of personal mobile technologies for lifelong learning. *Computers & Education*(34), 177-193.

Sparrow, B., Liu, J., & Wegner, D. M. (2011). Google effects on memory: cognitive consequences of having information at our fingertips. *Science, 333*(6043), 776-778. doi:10.1126/science.1207745

Statistical Yearbook 2014. (2014). In G. F. S. Office (Ed.). Stuttgart, Germany: Metzler Poeschel.

Tapscott, D. (1999). Educating the Net Generation. *Educational Leadership, 56*(5), 6-11.

Thompson, P. (2013). The digital natives as learners: Technology use patterns and approaches to learning. *Computers & Education, 65*, 12-33. doi:http://dx.doi.org/10.1016/j.compedu.2012.12.022

Traxler, J. (2008). Mobile Subcultures. In W. Steve (Ed.), *Connected minds, emerging cultures: Cybercultures in online learning* (pp. 17-28). NC: Information Age Publisher.

Traxler, J. (2009). Current state of mobile learning. In M. Ally (Ed.), *Mobile Learning: Transforming the Delivery of Education and Training* (pp. 9-24): AU Press.

Wallace, S., Clark, M., & White, J. (2012). 'It's on my iPhone': attitudes to the use of mobile computing devices in medical education, a mixed-methods study. *BMJ Open, 2*(4), e001099. doi:10.1136/bmjopen-2012-001099

Woody, W. D., Daniel, D. B., & Baker, C. A. (2010). E-books or textbooks: Students prefer textbooks. *Computers & Education, 55*(3), 945-948. doi:10.1016/j.compedu.2010.04.005

Supporting Information Legend

Course Period	Day	Participant number
teaching	1*	29
teaching	2	75
teaching	3	68
teaching	4	56
teaching	5	50
teaching	6	74
teaching	7	59
teaching	8	69
teaching	9	67
teaching	10	57
teaching	11	61
teaching	12	61
teaching	13	75
teaching	14	69
teaching	15	77
teaching	16	73
teaching	17	62
teaching	18	59
teaching	19	74
teaching	20	84
teaching	21	85
teaching	22	82
teaching	23	97
teaching	24	79
teaching	25	79
self-study	26	91
self-study	27	89
self-study	28	115
self-study	29	105
self-study	30	108
self-study	31	105
self-study	32	110
self-study	33	109
self-study	34	100
self-study	35*	24
	Mean	79.5
	SD	18.2
	SEM	3.2

Table S1. Daily response rate of online survey. (Gutmann et al., 2015)
Responses of day 1 and 35 were omitted due to low participation numbers.

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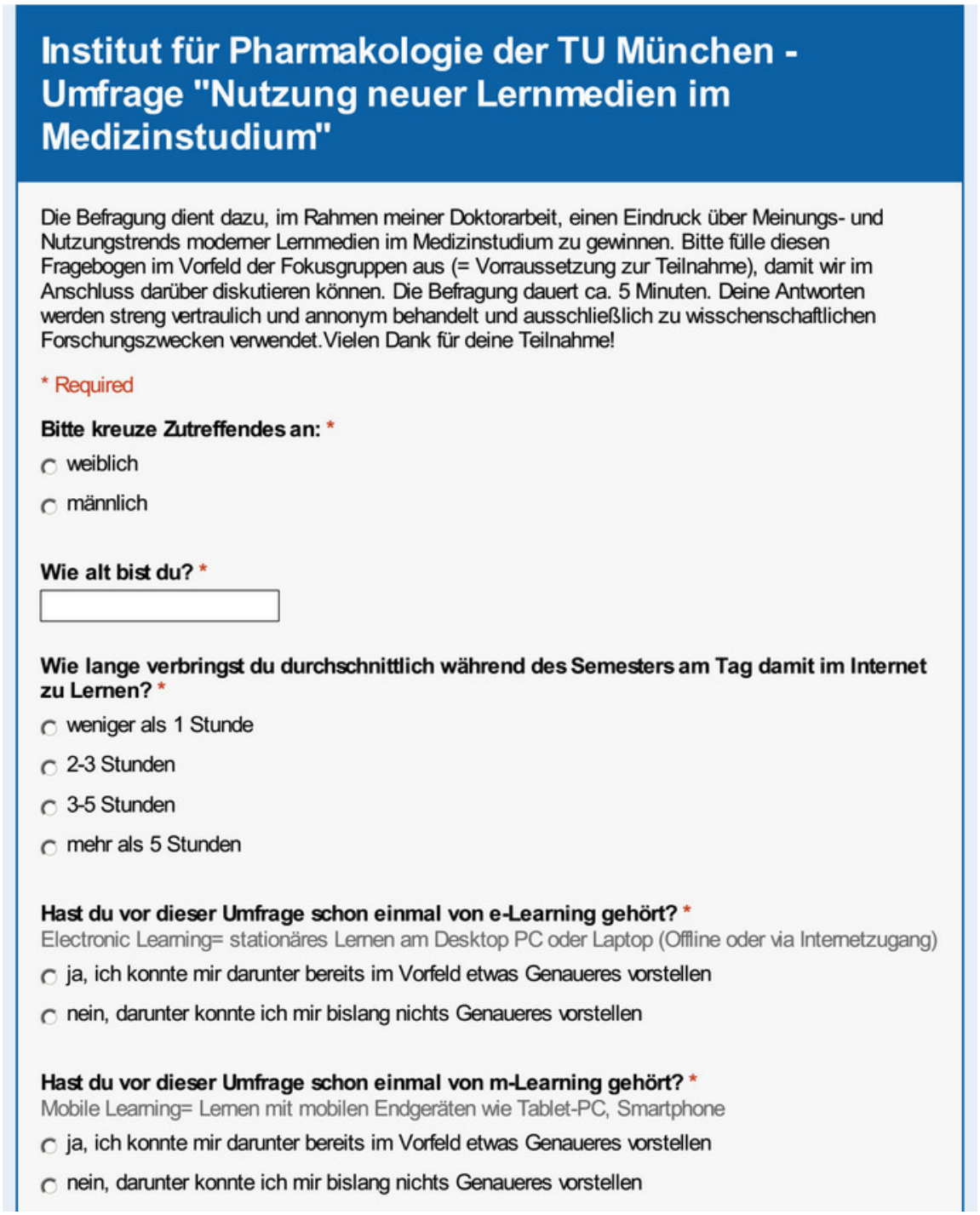
Appendix

1. Online Questionnaire about use of learning media during medical studies



Institut für Pharmakologie der TU München - Umfrage "Nutzung neuer Lernmedien im Medizinstudium"

Die Befragung dient dazu, im Rahmen meiner Doktorarbeit, einen Eindruck über Meinungs- und Nutzungstrends moderner Lernmedien im Medizinstudium zu gewinnen. Bitte fülle diesen Fragebogen im Vorfeld der Fokusgruppen aus (= Vorraussetzung zur Teilnahme), damit wir im Anschluss darüber diskutieren können. Die Befragung dauert ca. 5 Minuten. Deine Antworten werden streng vertraulich und annonym behandelt und ausschließlich zu wisschenschaftlichen Forschungszwecken verwendet.Vielen Dank für deine Teilnahme!

* Required

Bitte kreuze Zutreffendes an: *

- weiblich
- männlich

Wie alt bist du? *

Wie lange verbringst du durchschnittlich während des Semesters am Tag damit im Internet zu Lernen? *

- weniger als 1 Stunde
- 2-3 Stunden
- 3-5 Stunden
- mehr als 5 Stunden

Hast du vor dieser Umfrage schon einmal von e-Learning gehört? *

Electronic Learning= stationäres Lernen am Desktop PC oder Laptop (Offline oder via Internetzugang)

- ja, ich konnte mir darunter bereits im Vorfeld etwas Genaueres vorstellen
- nein, darunter konnte ich mir bislang nichts Genaueres vorstellen

Hast du vor dieser Umfrage schon einmal von m-Learning gehört? *

Mobile Learning= Lernen mit mobilen Endgeräten wie Tablet-PC, Smartphone

- ja, ich konnte mir darunter bereits im Vorfeld etwas Genaueres vorstellen
- nein, darunter konnte ich mir bislang nichts Genaueres vorstellen

○ nein, darunter konnte ich mir bislang nichts Genaueres vorstellen

Inwiefern stimmst du folgenden Aussagen zum Thema Mobile Learning im Medizinstudium zu: *

	Trifft völlig zu	Trifft zu	Trifft kaum zu	Trifft nicht zu
m-Learning ist eine nützliche Unterstützung zum Lernen mit klassischen Medien (Buch etc.)	○	○	○	○
m-Learning ermöglicht mir effizienteres Lernen	○	○	○	○
m-Learning ermöglicht mir meine Leerlaufzeiten (Buswartezeiten etc.) sinnvoll zu nutzen	○	○	○	○
Durch m-Learning habe ich jederzeit und von überall Zugriff auf Informationen	○	○	○	○

converte

Hast du schon einmal mit Lernapplikationen (Apps) auf einem mobilen Endgerät (Tablet-PC, Smartphone etc.) gelernt ? (AUßER TUM300) *

1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

	1	2	3	4	
ja, sehr oft	○	○	○	○	nein, noch nie

Hast du dich schon einmal damit auseinander gesetzt selbst eine "Lern-App" zu entwickeln? *

1= ja, sehr oft; 2= ja, gelegenlich; 3= ja, einmal; 4= nein, noch nie

	1	2	3	4	
ja, sehr oft	○	○	○	○	nein, noch nie

Hast du schon einmal Wikis (Wikipedia oä.) zum Lernen im Medizinstudium genutzt? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

1 2 3 4

ja, sehr oft ○ ○ ○ ○ nein, noch nie

Hast du selbst schon einmal einen Artikel zu einem medizinischen Thema auf Wikipedia oä. erstellt oder modifiziert? *
1= ja, sehr oft; 2= ja, gelentlich; 3= ja, einmal; 4= nein, noch nie

1 2 3 4

ja, sehr oft ○ ○ ○ ○ nein, noch nie

Hast du schon einmal Videos oder Video-Podcasts auf Video Plattformen wie YouTube oä. zum Lernen im Medizinstudium angeschaut? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

1 2 3 4

ja, sehr oft ○ ○ ○ ○ nein, noch nie

Hast du schon einmal ein eigenes Lehrvideo oder einen Video- Podcast über ein medizinisches Thema erarbeitet und auf YouTube oä. veröffentlicht? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

1 2 3 4

ja, sehr oft ○ ○ ○ ○ nein, noch nie

Hast du schon einmal Audio-Podcasts oder andere Audiodateien zum Lernen medizinischer Inhalte angehört? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

1 2 3 4

ja, sehr oft ○ ○ ○ ○ nein, noch nie

Hast du schon einmal selbst Audiodateien zum Lernen medizinischer Inhalte erstellt? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

1 2 3 4

ja, sehr oft ○ ○ ○ ○ nein, noch nie

Hast du schon einmal soziale Medien (Facebook, StudiVZ oä.) genutzt um medizinische Lerninhalte mit anderen Studenten/Dozenten auszutauschen? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

1 2 3 4

ja, sehr oft ○ ○ ○ ○ nein, noch nie

Bist du im Rahmen des Medizinstudiums ein AKTIVES Mitglied in einer Gruppe in einem sozialen Netzwerk (Facebookgruppe oä.)? *

○ ja

○ nein

Hast du dich schon einmal in einem Internetforum (Medilearn.de, DoccheckCampus oä.) über medizinische Lerninhalte informiert? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

1 2 3 4

ja, sehr oft ○ ○ ○ ○ nein, noch nie

Hast du schon einmal einen Beitrag zu einem medizinischen Thema in einem solchen Forum (Medilearn.de, DoccheckCampus oä.) verfasst oder kommentiert? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

1 2 3 4

ja, sehr oft ○ ○ ○ ○ nein, noch nie

Hast du schon einmal medizinische Informationen/Lernmaterialien von anderen Studenten/Dozenten via Media Sharing (Dropbox, GoogleDrive oä.) bekommen? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

1 2 3 4

ja, sehr oft ○ ○ ○ ○ nein, noch nie

Hast du selbst schon einmal medizinische Informationen/Lernmaterialien mit anderen Studenten/Dozenten via Media Sharing (Dropbox, GoogleDrive oä.) geteilt? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

1 2 3 4

ja, sehr oft ○ ○ ○ ○ nein, noch nie

Hast du schon einmal mit Online-Lernfällen für das Medizinstudium gelernt? (AUßER Pharmacases.de) *

1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

	1	2	3	4	
ja, sehr oft	○	○	○	○	nein, noch nie

Hast du dich schon einmal aktiv an der Erstellung eines Online-Lernfalles beteiligt? *

1= ja, sehr oft; 2= ja, einmal; 3= ja, gelegentlich; 4= nein, noch nie

	1	2	3	4	
ja, sehr oft	○	○	○	○	nein, noch nie

Hast du schon einmal über medizinische Lern-/Studiumsinhalte von anderen Studenten in einem Blog (DocCheck Blog, Medizin-Blog.info oä) gelesen? *

1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

	1	2	3	4	
ja, sehr oft	○	○	○	○	nein, noch nie

Hast du schon einmal in einem Blog eigene medizinische Lern-/Studiumsinhalte veröffentlicht? *

1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

	1	2	3	4	
ja, sehr oft	○	○	○	○	nein, noch nie

Verfolgst du aktuelle Tweets zu einem medizinischen Thema in einem Twitter Blog? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

	1	2	3	4	
ja, sehr oft	○	○	○	○	nein, noch nie

Hast du selbst schon einmal Tweets zu einem medizinischen Thema auf Twitter veröffentlicht? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

	1	2	3	4	
ja, sehr oft	○	○	○	○	nein, noch nie

Hast du schon einmal via Instant Messaging IM (Skype, Facebook oä.) mit Studienkollegen/Dozenten über ein medizinischen Lernthema gechattet? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

	1	2	3	4	
ja, sehr oft	○	○	○	○	nein, noch nie

Hast du selbst schon einmal AKTIV medizinische Lerninhalte mit anderen Studenten mittels IM geteilt (Dokumente hochladen, Links teilen etc.)? *
1= ja, sehr oft; 2= ja, gelegentlich; 3= ja, einmal; 4= nein, noch nie

	1	2	3	4	
ja, sehr oft	○	○	○	○	nein, noch nie

Welche der in der Liste aufgeführten modernen Lernmedien sind für dich beim Lernen im Medizinstudium generell am Wichtigsten? *
MAX. 3 Antwortmöglichkeiten auswählen!

- ☐ Mobile Learning (Lern-Apps auf einem mobilen Endgerät)
- ☐ Wikis (Wikipedia oä)
- ☐ Video- Dateien
- ☐ Soziale Netzwerke (Facebook, StudiVZ oä.)
- ☐ Internetforen (Medilearn.de, DoccheckCampus oä.)
- ☐ Media Sharing (GoogleDrive, Dropbox oä.)
- ☐ Lernfälle
- ☐ Blogs
- ☐ Twitter
- ☐ Instant Messaging (Skype oä.)
- ☐ Audio- Datein
- ☐ Other:

Welches der in der Liste aufgeführten modernen Lernmedien wünschst du dir zusätzlich als Unterstützung speziell im Fach Pharmakologie? MAX. 3 Antwortmöglichkeiten angeben! *
Es können auch bereits existente Medien genannt werden (wie Pharmacases, TUM300-App etc.)

- [ ] Mobile Learning (Pharma-Apps auf mobilen Endgeräten)
- [ ] Wikis (Einträge auf Wikipedia, Pharma-Wiki oä.)
- [ ] Pharma-spezifische Videos/Podcasts
- [ ] Austausch mit Dozenten/Studienkollegen via sozialer Medien (Facebookgruppe oä.)
- [ ] Unispezifisches Pharma-Forum
- [ ] Media Sharing von pharmakologischen Lerninhalten (GoogleDrive, Dropbox)
- [ ] Pharma-Lernfälle
- [ ] Pharmaspezifische Blogs
- [ ] Aktuelle Informationen zum Fach Pharmakologie über Twitter
- [ ] Kontakt zum Dozenten/Mitstudenten über Instant Messaging (Skype oä.)
- [ ] Pharmaspezifische Audio-Lerndatein
- [ ] Other:

2. Interview Guideline for telephone interviews

INTERVIEW LEITFADEN

DATUM:_____

TEILNEHMER NAME:_____CODE: _____

A. INFORMED CONSENT

I. Dissertation über Lernmediengebrauch des Instituts für Pharmakologie der TUM
II. Um Daten zu vervollständigen kurzes freiwilliges Telefoninterview
III. Gespräch wird aufgezeichnet, transkribiert und anonym zur wissenschaftlichen Auswertung verwendet
IV. Es werden keine personenbezogene Daten an Dritte weitergegeben

B. INTERVIEW

Du erinnerst dich doch sicherlich an die Online Umfrage, wo wir gefragt haben welche Lernmedien du am häufigsten genutzt hast. Dazu gehörten non-digitale Medien wie Bücher und Mitschriften, sowie digitale Medien wie Apps, Internetrecherche etc.

1. Ich habe anhand deines Codes im Verlauf gesehen, dass du **am häufigsten digitale/non-digitale** Medien genutzt hast

- Kannst du mir sagen **warum** du _____ bevorzugt genutzt hast?

_____
_____
_____
_____

2. Du hast zum Ende/am Anfang ja ein anderes Medium als am Ende/Anfang genutzt.

- Warum hast du das Lernmedium **gewechselt?**

_____
_____
_____
_____

3. Ist deine Lernmediennutzung auch in **anderen Fächern** so oder nur in Pharma?

Nur Pharma:_____
Generell:_____

4. Hattest du denn generell die **Möglichkeit** all diese Medien zu nutzen?

Beispiel: Hattest du z.b. Internet zuhause aber auch am Smartphone?

Ja:_____

Nein:_____

gen machen soll und Rückmeldung von Felizian habe, schicke ich es dir gedruckt zu.

5. Die Pharmakologie war ja quasi in 2 Phasen aufgeteilt: die ersten 3 Wochen mit den Vorlesungen und Seminaren, und die letzten Tage zum Eigenstudium:

- Hattest du wenn du das **Stressniveau** der ersten Phase und der zweiten Phase vergleichst hattest du dann gleich viel, weniger oder mehr Lern-Stress?

- weniger:_____
- mehr:_____
- gleich:_____

6. Ich habe gesehen, dass du vor allem **kontinuierlich/gegen Ende** gelernt hast:

- Ist das nur in dem Kurs, bzw. in dem Fach Pharma so gewesen, oder auch in anderen Fächern?

- nur Pharma:_____
- generell:_____

hängt das mit den Medien die du genutzt hast zusammen?

7. Zuletzt würde ich dich bitten, mir noch deine Klausurnote zu verraten, damit wir dein Nutzungsprofil mit Prüfungserfolg korrelieren. Es bleibt wie gesagt anonym.

- Note:_____

III. Ende

Wir sind jetzt am Ende des Interviews angekommen.

8. Hast du noch Fragen oder Vorschläge?

3. Interview Guideline for focus groups

Begrüßung, Dank für Teilnahme, eigene Vorstellung, Ziel der Studie:

Nochmal ein offizielles Hallo an alle, schön dass ihr alle gekommen seid.
Mein Name ist Joanna Gutmann. Wenn das ok für euch ist, würde ich euch das Du anbieten?
Ich führe im Rahmen meiner Doktorarbeit am Institut für Pharmakologie Gruppeninterviews durch, in denen es um den Einsatz neuer Lernmedien in der medizinischen Ausbildung geht. Im Fragebogen habe ich ja schon von euch wissen wollen, ob euch Mobile und E Learning überhaupt ein Begriff ist, welche Medien ihr in welchem Umfang nutzt, und ob ihr dabei eher passive Konsumenten oder aktive Beteiligte seid. In der Fokusgruppe heute möchte ich gerne eines dieser neuen Medien gezielt herausgreifen. Mich interessiert besonders wie verbreitet Mobile Learning unter euch Studenten bereits ist und welche Erfahrungen ihr damit habt. Abschließend werde ich dann auch noch auf den Fragebogen eingehen und gewisse Lernmedien gezielt herausgreifen und euch nach euren Erfahrungen fragen und was ihr euch speziell in der Pharmakologie wünscht. Diese Gruppendiskussion soll uns einen Eindruck über meinungs- und Nutzungstrends geben, wie wir mittelfristig die medizinische Lehre modernisieren und euren Bedürfnissen/Medienpräferenzen gezielter anpassen können. Ich habe euch dabei für diese Gruppendiskussion eingeladen, weil ihr euch freiwillig bereit erklärt habt dabei mitzuwirken und ich bin sicher, dass ihr mir bei meiner Forschung sehr weiter helfen könnt. Vielen Dank dass ihr euch alle für die Gruppendiskussionen gemeldet habt und ich hoffe, dass ihr auch davon profitiert und am Ende nach Hause geht und vielleicht besser aufgeklärt und informiert seid über den Einsatz neuer Lernemdien.

(1) Einverständniserklärung: (eventuell schon im Vorfeld)

Bei solchen Gruppendiskussionen ist es üblich, diese mit einem Diktiergerät und einer Videokamera aufzuzeichnen. Dies dient dazu, dass ich im Nachhinein noch einmal in das Gespräch reinhören kann, wenn ich mir bei bestimmten Dingen nicht mehr sicher bin, nachschauen kann wie die Aussagen formuliert wurden, und um das Gespräch zu transkribieren also schriftlich festzuhalten. Das Gespräch wird jedoch in anonymisierter Form gespeichert, sodass keinerlei Rückschlüsse auf euch als Person zu ziehen sind. Die Daten werden zudem nur für wissenschaftliche Zwecke im Rahmen meiner Doktorarbeit ausgewertet. Es erfolgt keine Weitergabe von Daten in personenbezogener Form an Dritte. Die Methode und Auswertung meiner Dissertation ist zudem von der Ethikkommission geprüft und genehmigt worden. Ich möchte euch auch bitten, dass alles was Einzelne von euch hier in dem Gespräch äußern, nicht nach außen getragen wird.
Seid ihr alle einverstanden, dass eure Gesprächsbeiträge aufgezeichnet und zu Forschungszwecken weiterverarbeitet werden? Wenn ja, dann könnt ihr jetzt alle einmal den vor euch liegenden Zustimmungszettel unterschreiben und an mich übergeben.

(2) Ablauf der Gruppendiskussion, offene Fragen:

Das Gruppeninterview wird in etwa 2h dauern. Wir werden heute genug Zeit haben, dass jeder von euch seinen Beitrag zu einem Thema äußern kann. Wichtig ist, dass ihr bei allen Fragen immer von euch selbst ausgehst, eure jeweils persönliche Meinung ist uns dabei sehr wichtig. Ich würde mich sehr freuen wenn ich zu den einzelnen Themengebieten eine Vielzahl von Meinungen von euch zu hören bekommen. Es ist dabei auch ganz wichtig, dass ihr offen miteinander diskutiert, jeder zu Wort kommt und ihr einander ausreden lasst. Es dürfen gerne ungleiche Meinungen diskutiert werden und Fragen untereinander gestellt werden.
Ich, als Moderator werde lediglich die Diskussion lenken, darauf achten dass jeder dazu kommt seine Meinung zu äußern und vielleicht einmal näher nachfragen. Das Gespräch an sich findet aber alleinig innerhalb eurer Gruppe statt. Ich möchte mich aber auch im Vorfeld schon entschuldigen und darauf hinweisen dass ich nicht unhöflich sein möchte, für den Fall dass ich euch einmal unterbreche, gerade gegen Ende hin, falls wir vom Thema abweichen oder ich aus zeitlichen Gründen zur nächsten Frage übergehen muss.
Welche organisatorischen Fragen habt ihr noch, bevor wir anfangen?
Hinweis: Kaffee, Kuchen/ Handy aus, Toilette bitte leise (im Treppenhaus im 1. Stock)

7. Kennenlernen:

Ich habe euch ja vorhin schon Namenschilder ausgeteilt. Bitte einmal euren Namen darauf schreiben und
Wenn ihr euch jetzt vielleicht noch einmal kurz persönlich der Gruppe vorstellt:

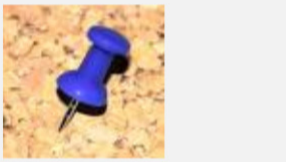
- euren Namen nennt
- wie alt ihr seid
- warum ihr euch zur Fokusgruppe gemeldet habt
- ob ihr ein Smartphone nutzt
- **wofür t ihr euer Handy, (egal ob Smartphone oder normales Telefon)überwiegend verwendet:**

Termine (Kalendar)
Kommunikation (Email, SMS, Chat, Telefon)
Internet surfen (ebay, amazon, Kochrezepte)
Nachrichten (Zeitung, NTV, Spiegel- News etc)
Spiele
Recherche (Googlen, Wikipedia etc)
Lernen (Pharmacases, TUM300 etc)
Sonstiges

(wird an FLIP CHART geschrieben und Striche gemacht: jeder hat drei Striche)

Kategorie	Hauptfragen (=Core question)	Anschließende Fragen (bei Bedarf) um Gespräch im Gang zu halten (=Probes)	Zusatz
A DEFINITION 	**Elektronisches Lernen ist ein Trend, an dem man als Medizinstudent heutzutage kaum noch vorbeikommt.** Ich möchte nun mit euch heute gezielt über das Thema **„Mobile Learning"** sprechen. Ich habe ja auch im Fragebogen schon nachgefragt ob ihr den Begriff Mobile Learning überhaupt kennt: **(1) WAS VERSTEHT IHR UNTER DEM BEGRIFF?**	Damit wir in der folgenden Diskussion vom gleichen ausgehen, erkläre ich euch jetzt noch einmal kurz, was man in der Forschung unter e-Learning und m-Learning versteht. Der Begriff **„Lernen"** wird dabei sehr weit verwendet, sprich sowohl aktives/passives Lernen, als auch kurzfristiges Nachschlagen/Wiederholen und langfristiges Lernen. Unsere Diskussion bezieht sich dabei konkret auf das Lernen im Rahmen des **Medizinstudiums.** Unter **Electronic Learning** (E-Learning) versteht man das stationäre Lernen an Desktop-PCs/Laptops daheim am Schreibtisch, oder in der Bib. **M Learning** oder auch Mobile Learning meint zeitlich und örtlich flexibles Lernen mit mobilen Endgeräten wie Tablet PCs oder Smartphones. =>Wenn ihr zum Beispiel unterwegs in der UBahn mit App TUM300 an eurem Smartphone ein paar Pharmaka nachschaut.	Auf **FLIPCHART** schreiben „Mobile Learning= Wissen to go Lernen mit MOBILEN, drahtlos vernetzte Endgeräte wie zum Beispiel Smartphones, Tablet, Netbooks." **POWER LEARNING**
B ERFAHRUNGEN	**(2) WAS SIND EURE ERFAHRUNGEN IM UMGANG MIT ML?**	⇨ Habt ihr schon mal mit zB eurem Smartphone gelernt? ⇨ Warum habt ihr so gelernt? Was war eure Motivation dafür? ⇨ Für welches Fach/zu welchem Thema habt ihr gelernt? ⇨ Welche Apps/Seiten etc. habt ihr dabei verwendet? **Falls nein:** ⇨ **Warum nicht? Was sind eure Gründe dagegen?** Falls nicht schon in Frage 2 beantwortet: ML bietet einem die Chance auch unterwegs bzw. in Leerlaufzeiten zu lernen. ⇨ **Was denkt ihr dazu?**	Beschreibt doch mal…

C KRITISCHE AUSEINANDERSETZUNG 	Im Fragebogen, den ihr ja auch am Ende der Klausur beantwortet habt, gab es vereinzelt Hinweise darauf, dass einige Mitstudenten Mobile Learning als unnötig, neumodisch, störend empfinden. **Manche gehen sogar soweit zu sagen, dass sei alles nur ein Technik-Hype, eine total überschätze technische Spielerei…** **Mich interessiert nun was ihr dazu denkt:** ➢ **Bitte alle einmal die rote Karte hochhalten wenn ihr NICHT zustimmt.** ➢ **Bitte alle einmal die grüne Karte hochhalten wenn ihr ZUSTIMMT** **(3)WARUM HABT IHR DAGEGEN/DAFÜR GESTIMMT?**	⇨ **Wie schätzt ihr die Situation ein?**	**JEDER TN HAT VOR SICH EINE ROTE UND EINE GRÜNE KARTE**
D SCHWIERIGKEITEN CHANCEN  	**Wenn wir uns jetzt mal konkret dem Einsatz von ML in der Lehre widmen** Hierzu haben wir hier eine Stellwand mit verschiedenen Kategorien denen wir uns jetzt Schritt für Schritt widmen werden und durchdiskutieren. Ihr bekommt dafür von mir Kärtchen in den jeweiligen Farben und dürft darauf schreiben was euch zu meinen Fragen spontan einfällt und ich hänge das dann an die Pinnwand, aber bevor ihr es aufschreibt, teilt euren Punkt mit der Gruppe. **Fangen wir mal an:** **(4)IST DENN DER EINSATZ IN DER LEHRE ÜBERHAUPT GEWÜNSCHT?** **(5)WO SEHT IHR AKTUELL NOCH SCHWIERIGKEITEN UND HINDERNISSE ZUM EINSATZ IN DER LEHRE?** **(6)WELCHE CHANCEN,**	⇨ **Was ist bei ML interessant im Vergleich zu anderen**	**PINNWAND**: Schwierigkeiten, Chancen, Wünsche, Lerninhalte  Geld, schlechtes Netz, technische Mittel, Internetzugang, adäquate Nutzung?, Kommunikationshindernis, kleines Display, nicht an der Klinik integriert, Selbstkontrolle, Ablenkung Zeit nutzen, Vielfalt, community-Vernetzung, örtlich unabhängig, zeit sparen, on demand Zugang,

	WELCHES POTENTIAL SEHT IHR IN ML IN DER MEDIZINISCHEN LEHRE?	**Methoden?**	Kommunikation= Lernen in der Gruppe, sofort recherchieren, spricht verschiedene Lerntypen an
E ENTWICKLUNGSWÜNSCHE 	**(7) WAS WÜNSCHT IHR EUCH NOCH BEZÜGLICH DER technischen ENTWICKLUNG BZW DER BENUTZERFREUNDLICHKEIT VON ML?**	⇨ **Wovon denkt ihr hängt der Erfolg von ML ab?** ⇨ **Was ist euch beim Lernen mit Mobilgeräten außerdem wichtig?** ⇨ **Wofür eignet sich ML besonders?**	Kontaktfunktion, soziale Vernetzung, Quiz, Design, Benutzerfreundlichkeit, Darstellung und Übersichtlichkeit, Praxisnähe, Lernzielkontrolle, Lernfälle, einfacher WLAN, Zugriff, Info über technische Voraussetzungen, Audioangebote, leichte Anmeldung, Feedback, integriertes Quiz, Karteikartensystem, knappe Inhalte, besseres Vorlesungsformat (ohne Dozent)
F MODERNE LERNMEDIEN 	Wir haben jetzt viel über ML gesprochen. Im Fragebogen habe ich ja noch verschiedene andere neue Medien aufgegriffen… **(8) WELCHE WEITEREN MEDIEN WÜRDET IHR EUCH IN DER MEDIZINISCHEN LEHRE WÜNSCHEN?**	⇨ **Welches Medium würde euch unterstützen und WARUM?**	Kompakte Videovorlesungen, Audio-Podcasts, virtuelle Fälle, Foren, Uni Twittergruppe, Blogs, TUM wik, Apps, drop Box, social mediai etc
	**(9) GLAUBT IHR DASS SOLCHE MEDIEN HILFREICH SIND BEIM LERNEN ODER SPIELEREI?** **Bitte alle einmal die rote Karte hochhalten wenn ihr glaubt ML ist eher eine SPIELEREI** **Bitte alle einmal die grüne Karte hochhalten, wenn ihr glaubt ML ist eher HILFREICH**	⇨ **Habt ihr das Gefühl, dass es für euch im Lernen tatsächlich hilfreich ist; euren Lernerfolg positiv beeinflust?**	Ablenkung, Spass, großes Angebot, Ergänzend, Motivation
G VERNETZUNG	**Die neuen Web 2.0-Werkzeuge Blogs, Podcasts, Wikis und weitere Social Media wie Facebook ermöglichen den Austausch über Bildungs- und Lernthemen mit den Kommilitonen und Gleichgesinnten weltweit und fördern so die Vernetzung.** **(10) WIE WICHTIG IS EUCH DER KOMMUNIKATIONSAUSTAUSCH; DAS VERNETZT SEIN BEIM LERNEN?**	Ist die Interaktion mit anderen Studenten Lernansporn?	
G LERNINHALTE 	**(11) WELCHE LERNINHALTE WÜNSCHT IHR EUCH FÜR ML?**		Wirkstoffe, Standardabläufe, Leitlinien, EKG, Sono/Radio Auswertung,

			herz/Atemgeräusche
H PASSIVITÄT 	**Lernen ist ein „Wissensbildungsprozess“ und bedeutet nicht, nur Wissen passiv zu konsumieren sondern auch aktiv mitzugestalten:** **(12) WIE ICH ANHAND EURER ANTWORTEN IM FRAGEBOGEN FESTSTELLEN KONNTE SEID IHR ÜBERWIEGEND PASSIVE NUTZER DIESER NEUEN MEDIEN: WORAN LIEGT DAS?**	⇨ **Was hindert euch daran?** ⇨ **Welche Ängste habt ihr?**	Technisches Hindernis, alles noch zu neu, kein Interesse, noch nicht damit beschäftigt, **Angst vor Datenschutz, Gewohnheit, Zeitmangel für Auseinadersetzung**
H QUALITÄTSKONTROLLE	Mit unserer TUm300 App ist es ja so, dass sowohl PJ Studenten, als auch Fachexperten die Inhalte immer wieder überprüfen. Ganz anders ist es ja zum Beispiel bei Wikipedia, wo ja		
	jeder einen Beitrag erstellen oder modifizieren kann. Dennoch scheinen sehr viele Medizinstudenten Wikipedia zur Recherche zu nutzen. **AUF DER EINEN SEITE DER VORTEIL DER KOLLEKTIVEN INTELLIGENZ; AUF DER ANDEREN SEITE DIE VERTRAUENSWÜRDIGKEIT IM NETZ:** **(13) MACHT IHR EUCH EIGENTLICH GEDANKEN ÜBER DIE INFORMATIONSQUALITÄT DER DATEN?**	⇨ **Ist es euch überhaupt wichtig, dass ihr wisst, dass die Informationen aus dem Netzt auch stimmen?** ⇨ **Wie findet ihr das, dass ihr bei der TUm300App eine Qualitätskontrolle habt?**	
I PHARMA 	**Wir haben jetzt ja viel über Lernmedien in der Lehre allgemein gesprochen. Mich interessiert jetzt noch wie es speziell mit der Pharmakologie ist.** Wenn ihr euch jetzt mal so unsere Ergebnisse auf den Pinnwänden anschaut. **LASSEN SICH EURE ERGEBNISSE SO AUCH AUF DIE PHAMA-LEHRE ANWENDEN?** **Wie ihr wisst, bieten wir in der Pharmakologie Lehre ja bereits ausführliche Pharmacases Lernfälle und die App TUM300 an:** **(14) WAS WÜNSCHT IHR EUCH**	⇨ **Gibt es Besonderheiten, die für die Pharmakologie anders sind?**	FLIP Chart

	SPEZIELL NOCH FÜR LERNMEDIEN IN DER PHARMAKOLOGIE? Fällt euch sonst noch etwas zu den anderen Kategorien ein was ihr noch ergänzen wollt?	⇨ **Warum? Was wollt ihr konkret?**	
F ZUKUNFT 	**Ihr habt jetzt heue viel über Mobile Learning erfahren. Was glaubt ihr abschließend:** **(15) WIE WICHTIG WIRD MOBILE LEARNING FÜR EUCH IHM ZUKÜNFTIGEN STUDIUM WERDEN?** **Bitte alle einmal die rote Karte hochhalten wenn ihr glaubt ML wird eher UNWICHTIG für euch sein** **Bitte alle einmal die grüne Karte hochhalten, wenn ihr glaubt ML wird WICHTIG für euch sein**	⇨ **Warum habt ihr euch so entschieden?**	**JEDER TN HAT VOR SICH EINE ROTE UND EINE GRÜNE KARTE** **GRÜN= WICHTIG, ROT=UNWICHTIG**

8. Dank für Teilnahme:

Dass habe ich namentlich im Dokument erwähnt und ihm auch eine Email geschrieben mit dem Textteil und ihr gebeten einzufügen was noch erwähnt werden muss. Ich habe das ja nicht programmiert und kann daher dazu es näheres schreiben.

Vielen Dank, dass ihr euch die Zeit genommen habt, an dieser Gruppendiskussion teilzunehmen und dass ihr so rege mitdiskutiert habt. Ihr habt mir bei meiner Studie damit sehr weitergeholfen.

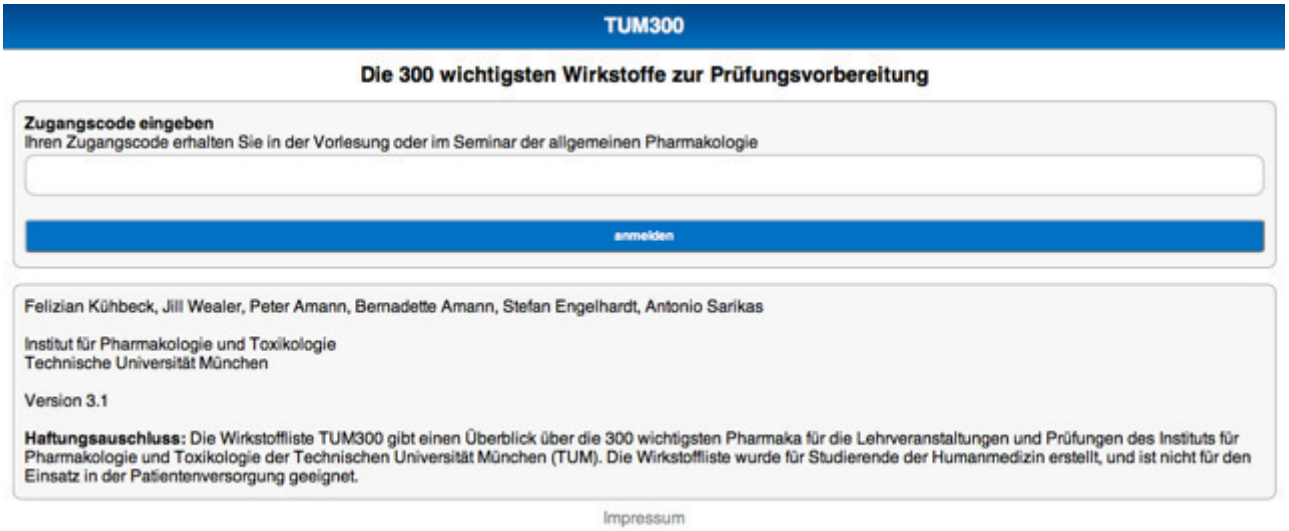
9. Feedback

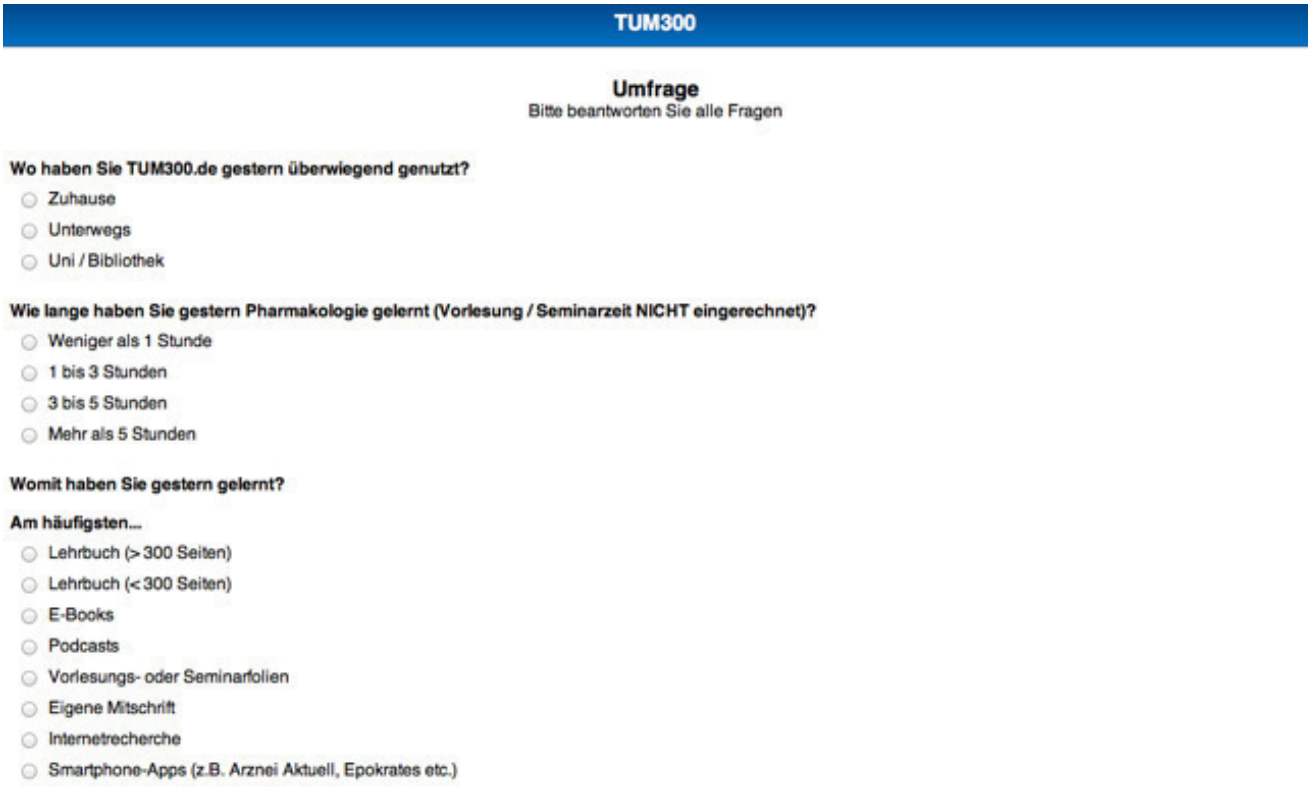
Wie empfandet ihr das Interview? Welche Fragen habt ihr denn noch?

10. Verabschiedung

Dann bedanke ich mich noch einmal ganz herzlich bei euch allen. Falls ihr noch weitere Fragen oder Anregungen habt, könnt ihr mir gerne eine Email schreiben.
Ihr dürft jetzt gerne noch einmal Trinken und eine Kleinigkeit essen.

4. Daily Online Questionnaire





Note: second most media, and third most media are omitted on the screenshot