

Mémoire de Maîtrise en médecine No 4399

# M-learning for medical students during clinical training: the paradigm of pediatric endocrinology-diabetology

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Lausanne, 15.01.2018

# M-learning for medical students during clinical training: the paradigm of pediatric endocrinology-diabetology

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## Abstract

### Background

Internet-based research and smartphone use is a growing part of medical student learning. These modes provide opportunities to rapidly access information - albeit from sometimes unfiltered, non-peer-reviewed or untrustworthy sites. Specialized, fee-for-service digital mobile learning (m-learning) options exist, yet these are not always adapted to specific university curricula. To address this gap, we developed a digital solution for medical students integrating medical information parallel to a structured curriculum for teachers/students during clinical courses and clinical internship. This m-learning platform serves as a gateway to access the university's electronic learning platforms (e.g. Moodle) as well as a catalyst facilitating active, team-based learning.

### Methods

We evaluated the pilot use of the structured m-learning platform (PedLaus) for pediatric endocrinology and diabetology. Medical students during their 3<sup>rd</sup> and 5<sup>th</sup> year of training completed a structured online questionnaire. Descriptive statistics and chi square analysis were employed to analyze data on internet use and usability and acceptability of the PedLaus platform/content.

### Results

In total, 67 (34%) 3<sup>rd</sup> year (clinical coursework) and 39 (20%) 5<sup>th</sup> year students (internship) completed the questionnaire. In both groups, Wikipedia was the most commonly used information source of medical information (50/67, 75% and 29/39, 75% respectively). Google was utilized by 47/67 (3<sup>rd</sup>) and 24/39 (5<sup>th</sup>) students as search method. Between 59-66 % (44/67 of 3<sup>rd</sup> year and 23/39 of 5<sup>th</sup> year) of students consulted their university lecture notes/documentation. Smartphone use differed according to year of study. A third (23/67, 34%) of 3<sup>rd</sup> year students reported using a smartphone to search for information during clerkship as compared to 33/39 (85%) of 5<sup>th</sup> year students ( $p < 0.005$ ). Medical library use was relatively low, 27% of 3<sup>rd</sup> year and 28% of 5<sup>th</sup> year. PedLaus received high marks for acceptability and usability. Students perceived PedLaus as adapted to their level of knowledge and fast and easy to access.

### Discussion

Medical students frequently search information using Wikipedia or Google. These data highlight the need for universities to reflect on pedagogical approach and adapt materials and methods to

incorporate reliable content that is actually used by students. This pilot PedLaus project provides a framework enabling teachers to guide learning and students to easily and rapidly access clinical information on a smartphone during active learning exercises and clinical encounters. This m-learning tool is an acceptable and easily accessible complement to classical didactic methods of clinical courses.

### **Conclusion**

Universities need to adapt current knowledge transfer strategies into the curricula and integrate technology used by medical students. PedLaus combines a rapid, open content search platform with high-quality and reliable medical information for students that is a useful reference for clinical training.

**Introduction:**

Medical students are required to absorb a great deal of information during medical education. Unfortunately, much of this knowledge will have been forgotten when they are in front of a patient<sup>1</sup>. Mobile learning (m-learning), which is rapidly spreading due to the ubiquitous use of smartphones, refers to a form of electronic learning (e-learning) that is not fixed to a particular location (i.e. via tablet or smartphone). It enables one to search and gather information asynchronously, without being tethered to a computer<sup>2,3</sup> but simply by using a portable and pocket-sized tool<sup>4</sup>.

Another type of internet-enabled learning is the university-based knowledge transfer platform. This is a platform contains information but lacks the interactive component of e-/m-learning. Knowledge transfer platforms might be a complement and a gateway to e-learning.

It is important to elucidate several terms related to knowledge and learning. Knowledge can be separated into two categories; factual and procedural forms. In medical education, acquiring factual knowledge typically precedes procedural knowledge. Factual learning encompasses the theoretical aspects taught in the classroom while procedural knowledge is acquired with clinical experience. Studies demonstrate that students' long-term retention of factual knowledge is mediocre at best<sup>1</sup>.

As for learning, we distinguish passive and active form. The teacher-student transfer of knowledge can take place in structured, large audience classes, small groups, or through individual work. Passive learning is the traditional method of teaching<sup>5</sup>, i.e, students listen to lectures without much interaction<sup>6</sup>. This is suboptimal as it decreases the students' attention. Students have been known to sleep in class, send text messages, talk with each other or play on their mobile phones<sup>5</sup>.

In contrast, active learning is a broad term describing numerous approaches to instruction that hold students responsible for individual learning<sup>5</sup>. Examples of active learning include role-play, lectures for students to consolidate notes, small group discussions or quizzes<sup>5,6,7</sup>. Classical passive didactic lectures are being progressively replaced with digital solutions (e.g. internet based e-learning or vodcasts<sup>8</sup>) and could eventually be substituted with augmented reality<sup>9</sup>. Group built solutions like team based

learning (TBL)<sup>10</sup> are being developed to integrate factual knowledge and teaching strategies to solve defined problems. However, this approach still relies on preparatory material in line with course learning objectives.

Currently, students have a plethora of teachers and learning material, yet passive, factual, slide-based presentations still predominate<sup>12</sup>. More importantly, medical knowledge is growing on a daily basis making it hard to keep pace with the volume of new discoveries and publications<sup>1</sup>.

M-learning applications have multiplied and recent research<sup>13</sup> has been focusing on patterns of searching for evidence and factors influencing use, success, implementation and adoption of such tools<sup>14</sup>. However, we know that the transfer of knowledge is as much required as the transfer of experience by a teacher.

In ancient Greece, there were no licensed doctors. Doctors learned to treat people through the practical transfer by others<sup>15</sup>. We can presume that this was a very active and procedural way of learning, but the student relied solely on the experience and knowledge of a single teacher.

M-learning knowledge transfer platforms can be described by active and passive learning. Whilst there is no direct interaction with a teacher, students are responsible for their learning when they use this tool<sup>5</sup>. Moreover, knowledge transfer platform allows students to consolidate their notes as is described in the definition of active learning<sup>5</sup>. A recent study showed that the addition of a m-learning tool after a classroom lesson improved clinical knowledge compared to the classical course<sup>16</sup>.

Consequently, with m-learning, information can be updated regularly as opposed to books<sup>17</sup> and the student can be up to date with current medical knowledge<sup>18</sup>.

In modern days, smartphones have become essential in a students' learning cycle. Today, internet research and e-journals have widely exceeded printed books from the library<sup>19</sup>.

New technologies develop faster and faster especially in developed countries where most students have access to internet and smartphones. In a UK study, 68.9 % of 5<sup>th</sup> year medical students consider themselves frequent users of smartphones, exceeding 12 times per day<sup>2</sup>.

Being able to get an answer instantly might allow them to better integrate the information<sup>20</sup>. Unfortunately, it is still difficult to find appropriate data. A German study from 2012 shows that 74% of medical students use Wikipedia as a main source when looking for clinical information even though data published on Wikipedia is not always verified by health care professionals<sup>21</sup>. In an ideal world, information should be accessible rapidly but above all should be trustful. In short, “Students need to be able to access information that is delivered by systems that are effective, easy to use, focused on users’ needs and are robust”<sup>19</sup>.

M-learning is especially useful for young inexperienced healthcare professionals who seek the best answers to their clinical problems but are overloaded by their daily tasks. A smartphone would help them instantly, wherever they are working<sup>22</sup>. Learning through mobile phones equips them for self-managed learning<sup>23</sup>. Nevertheless, there are other factors to take into account to be able to have to optimal mobile-learning experience.

Some medical information applications such as Amboss or Epocrates already exist but are expensive and therefore not affordable to all students<sup>24</sup>. Also, most of the apps focus on physiopathology and diseases but no existing m-learning platform focuses on the experience of the patient<sup>25</sup>. More crucially, the providers of the information are not really known.

It therefore seems essential to develop tools with named authors who can be trusted.

The first aim of our study was to develop and evaluate a new teaching approach and integrate m-learning into the structured curriculum.

The second aim was to evaluate the student use of mobile resources as well as the students’ approval of the new m-learning model.

## **Methods:**

We aimed to develop and evaluate a digital m-learning solution for medical students during specialty training in pediatric endocrinology and diabetology. The goal was two-fold. First, we intended to create a web-based platform for students, providing brief, accurate medical information to complement

didactic lectures and classroom-based active learning exercises (i.e. small group discussion, workshops, group projects). Second, we aimed to develop a resource for students as they entered clinical rotations providing direct access to content authors for additional questions as needed.

#### *The m-learning tool: PedLaus*

To develop the website, we used a specific, simple, structured WordPress template that is adaptable for PC, tablet and mobile phone formats. A specific identifying design was created to render the site and articles visually attractive and concise. The site is hosted on the main site of the University of Lausanne ([www.unil.ch/pedlaus](http://www.unil.ch/pedlaus)). Teachers and doctors of the Lausanne University created the clinical data available on the site. Published PedLaus articles follow structured technical writing rules, including language and syntax, ensuring briefness and a unique coherent design intended to optimize searches and minimize the time required to access information (figure 5). The structure follows the curriculum of the 3<sup>rd</sup> year pediatric clinical courses with embedded links to the university's Moodle site and learning modules.

Articles are prepared by instructors using a structured PDF form allowing content searches via metadata such as key words, category, age groups, and tagged images.

#### *Medical student population*

A cross-sectional survey was conducted in 2016-2017 among 3<sup>rd</sup> and 5<sup>th</sup> year medical students at the University of Lausanne. The 3<sup>rd</sup> year, which is the final year of Bachelor preparation, marks the beginning of clinical coursework (Figure 1). 5<sup>th</sup> year students are in the second year of their Masters' degree and are relatively more experienced clinically.

The m-learning platform was presented to the 3<sup>rd</sup> year students and clinical classes were given based on the m-learning platform class during pediatric endocrinology lectures prior to the study questionnaire. The site was launched prior to the courses and was used by instructors during lectures

and active learning class exercises to facilitate students' focus on comprehension of the course material and discussions. All students were advised to study the content of the website to prepare for final exams as tests did not include any content from third-party sites. The 5<sup>th</sup> year class served as a control group. They were not introduced to the m-learning platform prior to the study questionnaire.

#### *PedLaus Evaluation*

After course completion, a structured web-based questionnaire was sent by to all 3<sup>rd</sup> year students (n=197, having used PedLaus during courses) and all 5<sup>th</sup> year medical students (n=193, during their clinical internships). The questionnaire was hosted on the university server and participation was voluntary. Anonymized questionnaire data were collected on use of internet-resources for learning and revision, and specific questions about the proposed solution

#### *Analysis*

Questionnaire data were reported using descriptive statistics. Chi square was employed to compare categorical results between 3<sup>rd</sup> and 5<sup>th</sup> year medical students. A *p* value of <0.05 was considered statistically significant.

#### **Results:**

Response rate reached 43% (85/197) among 3<sup>rd</sup> year students and 33% (64/193) among 5<sup>th</sup> year students.

For evaluation, we only considered fully completed questionnaires: 67/197 (34%) for 3<sup>rd</sup> year (55 % female, 45 % male), and 39/193 (20.2%) of 5<sup>th</sup> year students (69% female, 31% male). Only 2 students responded not having a smartphone.

#### Smartphone use during medical studies

Both groups reported using a smartphone primarily for communication with peers (3<sup>rd</sup> year: 61/67, 91%, 5<sup>th</sup> year: 38/39, 97%) (99/106, 93%) and for accessing information rapidly (3<sup>rd</sup> year: 56/67, 84%,



5<sup>th</sup> year: 35/39, 90%) (figure 2). Relatively few (3<sup>rd</sup> year: 12/67, 18%, 5<sup>th</sup> year: 5/39, 13%) use their smartphone to either read an article or book but reported using a computer to read articles (5<sup>th</sup>: 30/39, 77%), to access information (5<sup>th</sup>: 34/39, 87%) and to create content (figure2)

Only 34% (23/67) of the 3<sup>rd</sup> year students used their smartphone to look for clinical information during clerkship and bedside teaching, whereas most of the 5<sup>th</sup> year students (33/39, 85%) used it for this purpose (difference  $p < 0.005$ ) (Figure 4). Three-quarters (79/106, 75%) of both student groups (3<sup>rd</sup> and 5<sup>th</sup> year) consulted Wikipedia while two-thirds (71/106, 67%) searched using Google which is considered the more reliable resource. The same proportion (71/106, 67%) stated they consulted their university lecture notes/materials. Notably, only about 27% (3<sup>rd</sup> and 5<sup>th</sup> years: 29/106) students visited the medical library to find clinical information.

#### Evaluation of PedLaus

Overall, most students rated PedLaus as easy to access by smartphone and computer. The majority of students (3<sup>rd</sup> and 5<sup>th</sup> years: 95/106, 90%) reported that reading a PedLaus article was fast and took less than 5 minutes. Furthermore, the content was deemed appropriate to the students' level of knowledge as 98.5% (3<sup>rd</sup>, 66/67) and 100% (5<sup>th</sup>) of students rated it as adapted to their current knowledge. All students (3<sup>rd</sup> and 5<sup>th</sup> years: 106/106, 100%) were satisfied with the PedLaus knowledge transfer platform. Students said they would likely use it during their pediatric rotations (3<sup>rd</sup> year: 54/67, 80%, 5<sup>th</sup> year: 32/39, 82%).

There was also a spillover effect. Students not formally introduced or oriented to the site appreciated the potential benefits and reported that they planned to use it. Interestingly, 43 /67 (64 %) of 3<sup>rd</sup> year students and 29/39 (74%) of 5<sup>th</sup> year students expressed a desire to have more e-learning/m-learning integrated in the university's medical education curriculum (figure 5).

We also asked students about the strengths and weaknesses of the platform (table 2). Comments frequently centered on ease of use and trustworthiness with comments such as: "[it is] clear and simple

use”, “[I] trust what is written”. Students noted that to improve PedLaus, additional clinical specialties should be added.

### **Discussion:**

Herein we present data demonstrating that medical students frequently access medical information and resources using their smartphones. We found a significant difference (34% vs 85%,  $p < 0.005$ ) in smartphone use to access internet resources between 3<sup>rd</sup> and 5<sup>th</sup> year medical students. This may reflect different levels of knowledge between these two groups. Moreover, 5<sup>th</sup> year students are more autonomous compared to 3<sup>rd</sup> year students who may rely more heavily on notes and classroom documents part of their university courses.

Our finding that most medical information is accessed via Wikipedia or Google, and that the medical library is rarely resorted to is important for universities as they may need to reconsider offering supplemental course material. Reliance on coursework notes and material ranked 3<sup>rd</sup>, underscoring the importance of providing students with reliable content that is presented during lectures, used during team-based learning sessions, and applied in clinical internships.

In our study, three-quarters of students used Wikipedia to search for medical information despite the fact that there is no assurance of accuracy or peer-reviewed validation. While students’ beliefs and motivations were not explored, this observation might be due to time constraints as well as the ease and rapidity of searching via Wikipedia. Furthermore, this finding suggests that even students with some clinical practice, face time constraints that prevent them from visiting a traditional medical library. Thus, teachers and universities may need to rethink the learning environments and the pedagogical approach for medical students who are so-called ‘digital natives’ - meaning that they have grown up with easy access to technology and the internet. Given the considerable time constraints when searching for information and the simplicity of accessing a mobile device, it is perhaps not surprising that the smartphone has become the default ‘go-to’ for these students. A similar study was conducted in the United Kingdom in 2015 that surveyed two medical students’ classes (4<sup>th</sup> and 5<sup>th</sup> year)

about smartphone e-learning during internship <sup>2</sup>. Researchers identified that 77 % of students perceived the smartphone “to be an effective tool for learning new material” and 59% stated that smartphones are “effective for revisiting previously learnt material”<sup>2</sup>. Consistent with the present data, the investigators highlight that 5<sup>th</sup> year students have more experience with smartphones during clerkship <sup>2</sup>.

The students’ open-ended comments provided diverse information and perspectives (Table 2). Most comments described PedLaus as ‘clear’ and ‘easy to use’. This was encouraging as creating an intuitive digital solution was a priority. We were also reassured by the fact that students said they trusted the content – thus filling one of the major concerns raised by the frequent use for Wikipedia. Students also expressed the advantage of being able to respond to patients’ needs for reliable clinical information during their clinical encounters. This was a distinguishing feature from available web-based platform services (e.g. Amboss, Epocrates). Notably, some students indicated their desire to continue using PedLaus during postgraduate clinical practice and expressed desire for additional links and further current reading to provide deeper insight into specific topics.

In summary, PedLaus provides a digital platform that is formatted for smartphones enabling students to search for clinical information in a mobile fashion setting. The intuitive nature of the design promotes ease of use and the validated information, written by the same professionals who teach at the university, fosters confidence that information comes from a trusted source. Further, as students begin their clinical practice, they may benefit from having direct access to the content authors for further direct interaction as needed. It is important to note that as medical students begin their initial clinical encounters, they will come face-to-face with the suffering experienced by patients and families. Currently, there is no m-learning platform focusing on patient experience<sup>25</sup>. This may be an area for future development, promoting person-centered approaches to care in the era of value based medicine<sup>26</sup>.

This study has several limitations. First, it is a pilot project with a relatively small sample size and thus may not be representative of the practices and needs of all medical students. Second, a small minority of students may not feel comfortable with new technologies and/or do not own a smartphone (as was the case for two students in this study). As such, smartphones are a useful tool but may not be universal and anchored in everyone's daily habits.

The ongoing PedLaus project will include a rising number of clinical pediatric files stored on a common web based platform easily accessible from smartphones.

## **Conclusion**

This pilot study helped us understand student practices and needs in terms of new approaches to pedagogy and the complementary role of m-learning now and in the future. Students tend to search for medical information on Wikipedia and Google so as to have quick access to information while only a small minority use the traditional medical library system and materials from university courses to find trusted and reliable information. PedLaus is an m-learning digital solution that combines these two elements, enabling rapid search of validated medical information. Students in this study seemed to appreciate all these elements and the majority responded that they would use PedLaus during pediatric clerkship and clinical practice. Our approach which consisted of using an open system for content delivery to students, that can be used by instructors throughout pre-graduate medical school education and by the medical trainees during their clinical rounds as a quick reference appears logical and convenient. The fact that course instructors create and maintain content updates could cultivate and strengthen the student-university connection.

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### Funding

This work was supported by the Pediatric Endocrinology and Diabetology Unit at the University of Lausanne. The content of the article has not been influenced by sponsors.

### Conflict of interest

The authors declare that they have no competing interests.

### Authors' contribution

M.P. and M.H. designed the web based knowledge transfer platform, wrote the protocol, wrote the first clinical files, performed the study and wrote the first manuscript of the article. M.S. and I.M. developed the Wordpress webpage and the assured compliance with the University of Lausanne teaching standards. J.S. and D.C. created the web design. M.P., and A.D, analyzed and interpreted the data, created and edited figures and tables. M.H. designed and supervised the study and interpreted the results. All authors made contributions in editing and revising the article and approved the final version

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Figure 1: Structure of the University of Lausanne school of medicine. Medical studies last six years and is divided into two levels: Bachelor of Medicine (3 years) and Master of Medicine (3 years). The Bachelor level comprises coursework in basic science (physics, chemistry), an introduction to biomedical sciences (biochemistry, morphology, physiology) and human medical sciences/public health. The Master level concentrates on the theoretical foundation of pathology as well as the theoretical and practical basis of treatment. The integrated m-learning tool (PedLaus) is a complement to clinical courses and as a quick reference tool for later clinical work.

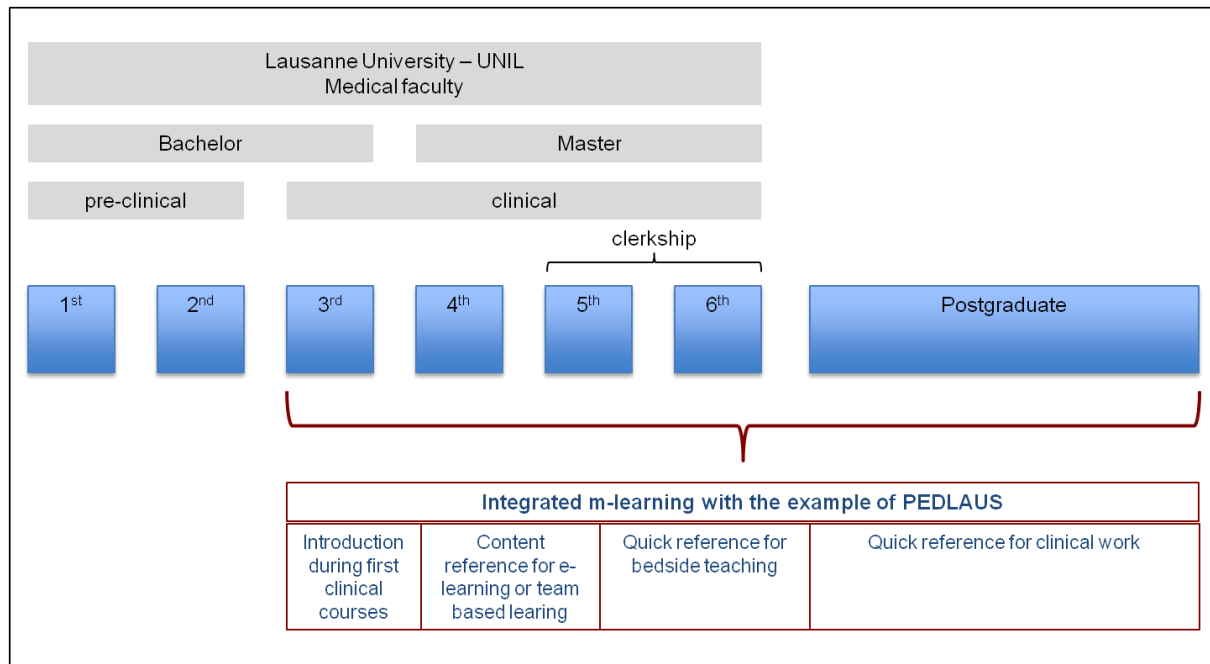


Figure 2: Smartphone and Computer use during medical studies in 3<sup>rd</sup> (n=67) and 5<sup>th</sup> year (n=39) students (multiple choices). In both classes, students reported using a smartphone primarily for communicating with peers and rapidly searching for information. Students reported using a computer for searching content and reading articles.

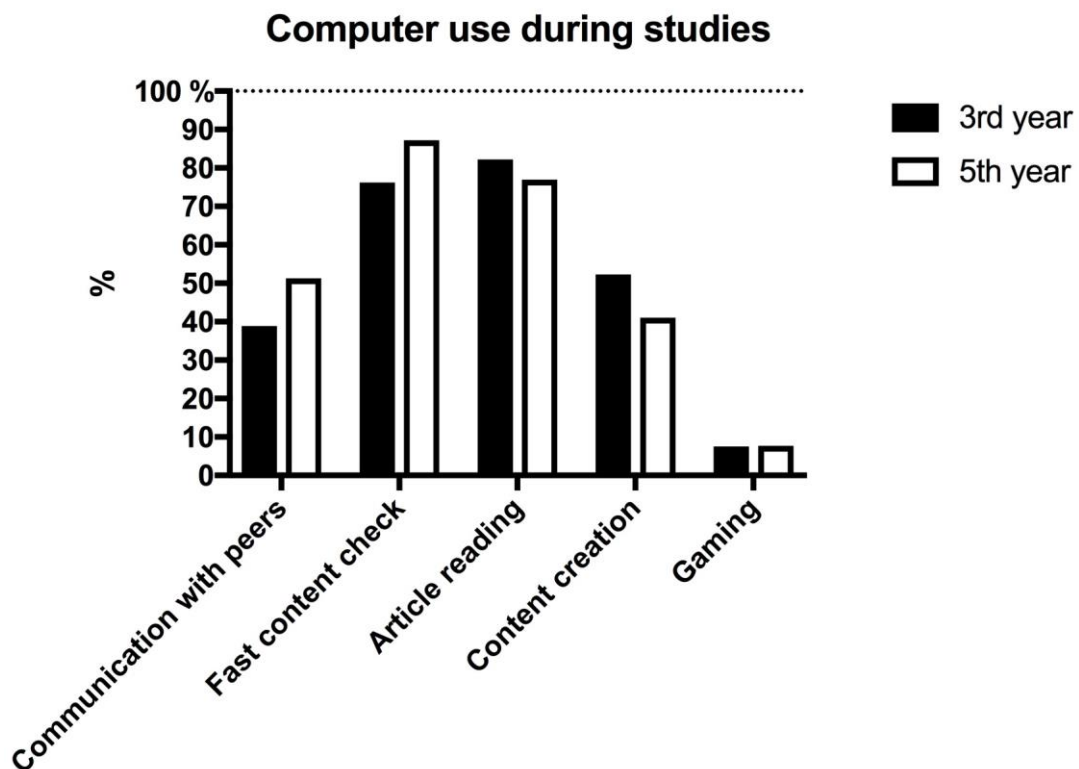
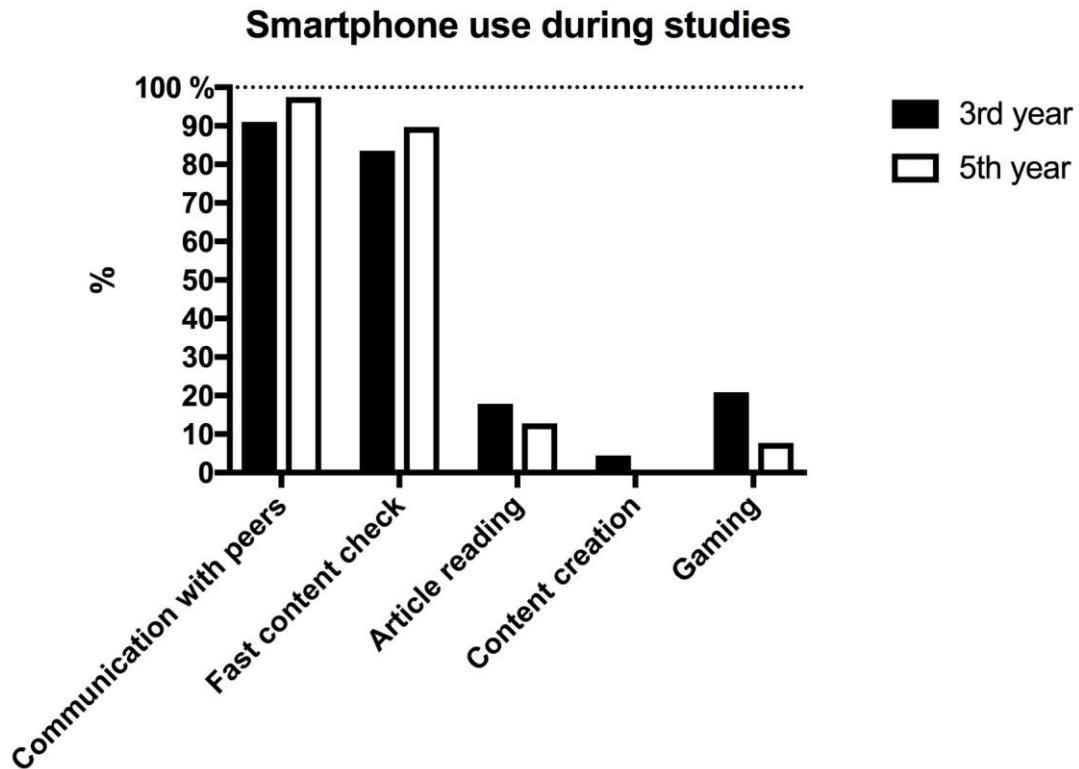


Figure 3: Learning resources used by medical students in the 3<sup>rd</sup> (n=67) and 5<sup>th</sup> year (n=39) during their studies (students could select multiple choices). The largest proportion of 3<sup>rd</sup> and 5<sup>th</sup> year students use Wikipedia. Similar proportions reported using Google and course materials to look up medical information. Up-to-date was only available to 5<sup>th</sup> year students.

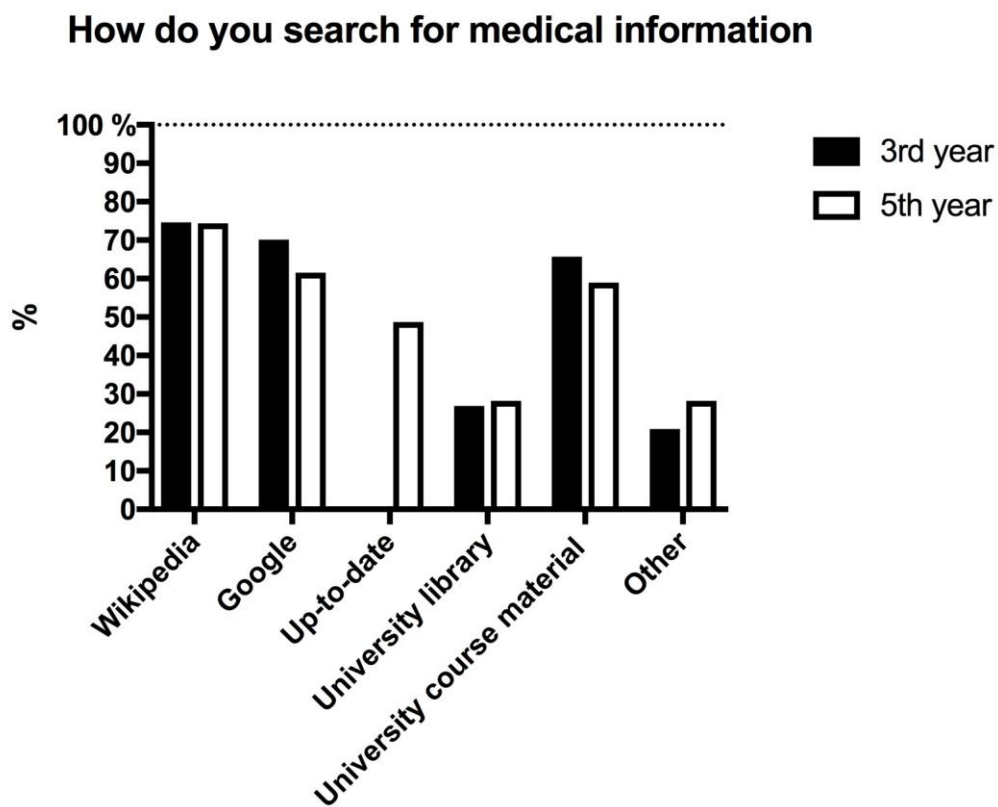


Figure 4: Smartphone use during clinical encounters and bedside teaching (single choice). The 3<sup>rd</sup> year students rarely used a smartphone to look for a medical information whereas. 5<sup>th</sup> year students, who are more experienced clinically, often use a smartphone for this purpose.

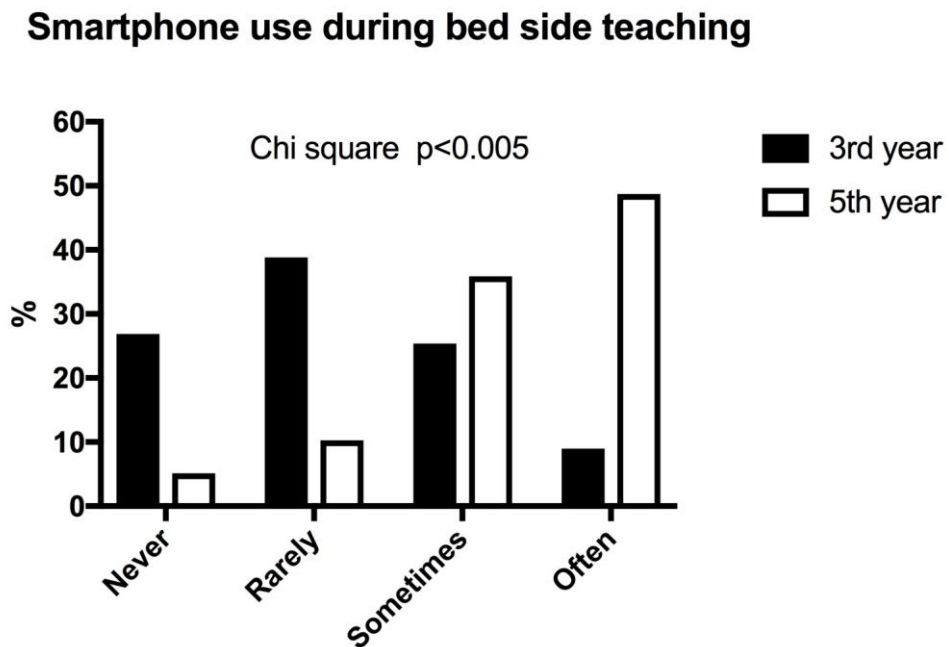


Figure 5: Acceptability and usability of PedLaus. Data are presented as mean  $\pm$  SD. 3<sup>rd</sup> year students are depicted as circles, 5<sup>th</sup> year students as squares.

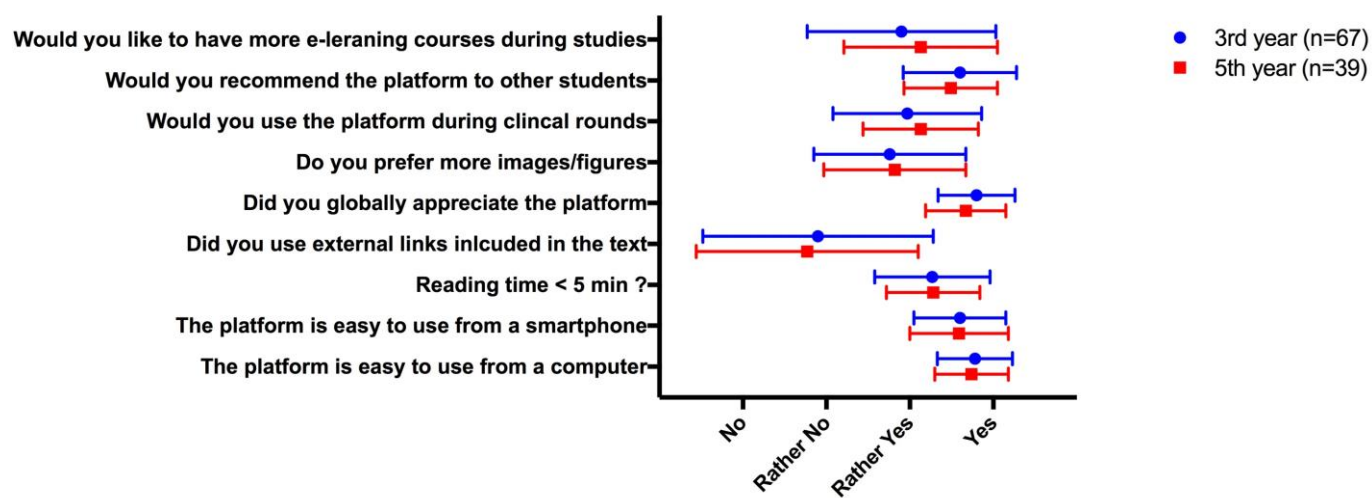


Figure 6: Graphical design outlines

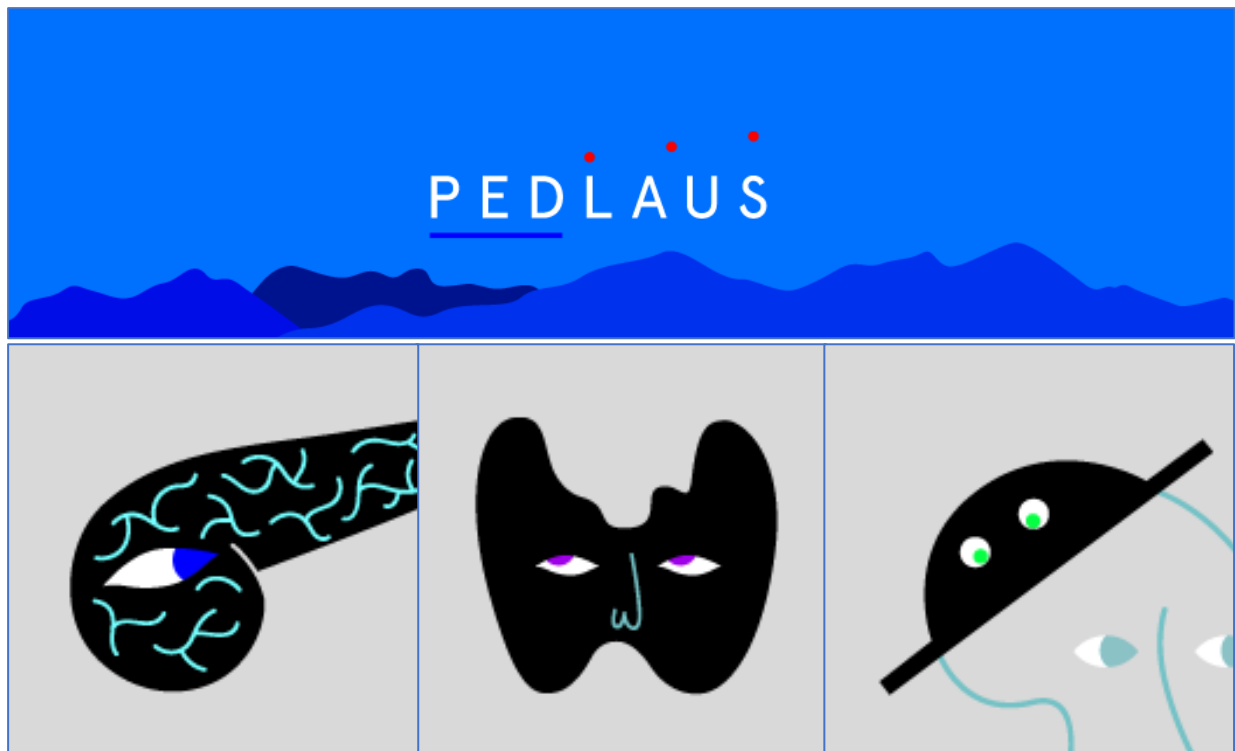


Table 2: Free-text student comments regarding PedLaus m-learning platform.

Comments (total number of students: 148)	
<i>Relative strengths</i>	« Clear and simple use» (38x)
	« To trust what is written» (10x)
<i>(50 students left comments)</i>	« To have all information included in the same place » (5x)
	« A fast access to the information» (3x)
	« Pleasant layout and adapted to smartphone » (3x)
	«It had a void. I never knew how to look for reliable information »
	« More practical than transport classes»
	« Saving time relative to search on Google »
<i>Areas for improvement</i>	«Add other specialties than pediatrics endocrinology »(7x)
<i>(46 students left comments)</i>	« M-learning using is not yet in our habits »
	« More pictures and tables »
	« Treatment table could be useful for each disease»