

The hurdles for adopting mobile learning devices at the outset of the clinical studies

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<p>Introduction: Mobile devices provide medical students with easy access to medical information and educational resources. Since 2013, we've followed the study use of iPads among the medical students. In 2016, we observed a notable drop in the overall mobile device usage in the first cohort of medical students entering their clinical studies.</p> <p>Aim of the study: In this study, we sought to identify the hurdles for adopting mobile devices among three consecutive cohorts of medical students at the beginning of their clinical studies. We sought to answer the following questions: (1) How did the students assess their own and their clinical teachers' ability to use iPads in learning and teaching? (2) How did the clinical before-class and in-class assignments support the students' use of the new technology? (3) How did students use the mobile device with patients?</p> <p>Material and methods: The data were collected with online surveys among the first three cohorts of medical students who had studied with iPads and started their clinical studies in the spring of 2016, the autumn of 2016 and the autumn 2017. In this study we focused on the closed-ended multiple choice and 5-point Likert scale questions which we analysed by the distribution frequencies in the three cohorts.</p> <p>Results: The response rates ranged from 67.5% (3rd cohort) to 90.8% (1st cohort). Students rated their own ability of using the iPad in studies as good or excellent whereas their teachers' ability to use these devices relatively low. The students wished for more pre-assignments (tests and videos) and in-class assignments (voting, tests and tasks) to stimulate their learning. Furthermore, they reported that clinical teachers seldom told them about applications related to their clinical field. The students primary use of mobile devices was for seeking information online. Students were hesitant in using the device in direct patient contact.</p> <p>Discussion: Our findings were consistent with previous research in observing a notable hesitation in using the mobile device with patients. These concerns were raised both among students and teachers. Furthermore, the teachers seldom communicated about suitable and quality medical applications. The clinical teachers require support and training in adopting mobile device compatible pre-class and in-class assignments in their instruction. (360 words)</p>			
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<p>Inledning: Mobila enheter tillgodoser medicinstuderanden med enkel åtkomst till information och undervisningskällor. Vi har följt studerandes användning av iPads inom studierna fr.o.m. 2013. År 2016 observerades en märkbar minskning i allmänna användningen av mobila enheter i den första kohorten då de inledde sina kliniska studier.</p> <p>Avhandlingens mål: I denna studie sökte vi efter hinder i ibruktagandet av mobila enheter för tre på varande följande årskurser vid inledningen av sina kliniska studier. Vi ville med studien besvara följande frågor: (1) Hur bedömde studerandena sina egna och sina lärares förmågor att använda iPads i inläring och undervisning? (2) Hur stödde kliniska förhands- och lektionsuppgifter studerandenas användning av den nya teknologin? (3) Hur använde studerandena sina mobila enheter med patienter?</p> <p>Material och metod: Data samlades med nätbaserade frågeformulär från de tre första årskurserna som hade studerat användandes iPads och inlett sina kliniska studier våren 2016, hösten 2016 och hösten 2017. Vi fokuserade i denna studie på slutna flervalfrågor och påstående graderade enligt en 5-steps Likert-skala vars svar analyserades enligt frekvensfördelningen för de tre årskurserna.</p> <p>Resultat: Svansandelarna varierade från 67,5% (årskursen 2018) till 90,8% (årskursen 2016). Studerandena uppgav sin egen förmåga att använda iPads i studier som god eller utmärkt medan de bedömde sina lärares förmågor som relativt svaga. Studerandena önskade fler förhandsuppgifter (tester och videor) och lektionsuppgifter (röstningar, tester och övningar) för att stimulera sin inläring. Vidare rapporterade de att kliniska lärare sällan berättade om applikationer relaterade till sin respektive specialitet. Studerandenas huvudsakliga användning av mobila enheter var för informationssökning på nätet. Studerandena var tveksamma när det gällde användning av iPads vid direkt patientkontakt.</p> <p>Diskussion: Våra observationer var i linje med tidigare forskning då det gällde tveksamheten för att använda den mobila enheten med patienter. Saken lyftes fram både bland studeranden och lärare. Vidare berättade lärare sällan om passliga medicinska applikationer av god kvalitet. Kliniska lärare behöver stöd och övning i inkorporerandet av förhands- och lektionsuppgifter som är kompatibla med mobila enheter i sin undervisning. (322 ord)</p>		
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1 Introduction

The tablets and smartphones of today provide learners with easy access to massive amounts of medical information and educational resources (1-3). With the quantity of medical knowledge increasing, no one doctor nor medical student can be expected to remember everything, a problem that's in part solved by mobile technology (2,4). As future doctors, today's medical students are the agents of change, enabling the integration of advantages of mobile devices into clinical patient care (5,6). Given the abundance of mobile devices (1,4) and emerging clinical technology (5,7), and further also the integration between user and technology (8), it is imperative to look into the benefits achieved with mobile technology also in medical education and practice.

Studies providing an insight into the entry of mobile technology-savvy medical students into the clinical setting are rapidly evolving (6). Overall, mobile device usage in educational contexts has a history of about a decade, and in accordance with the novelty of the phenomenon the studies on device usage have only recently accumulated (1,9) despite full iPad curriculums having existed since 2011 (3). Studies so far have found that students and junior doctors use mobile devices for searching information, time management, retrieving information before treating patients, reporting to senior colleagues and most importantly backing up their clinical reasoning and decision making (2,10), but more seldom in direct patient contact (6).

Studies focusing on mobile device usage in the clinical context so far have repeatedly raised the topic of hesitance in using the device with patients and have raised a serious concern of patients' reactions to mobile device usage, fears being that the students' devices would have a deteriorating effect on communication with the patient and could be interpreted as a sign of uncertainty and unprofessional behaviour (2,11). However, the few studies including patient interviews have mostly suggested that

patients are in favour of junior doctors using new technologies. Patients were comfortable with doctors using devices bedside to assist them in being better informed in diagnostic decision making (6,12).

The uncertainty of patients' reactions hasn't been the only major obstacle in adopting the new technology in the clinical context. Students' have also faced social barriers in the form of their device usage and online information seeking being construed as unprofessional behaviour and misinterpreted as personal use of social media by senior doctors and other healthcare professionals (13,14). Therefore, there's been a call for transparent guidelines and a code of conduct relating to mobile device use in the clinical setting (7,14).

Poor Internet access in teaching hospitals has been reported as one of the major barriers to the use of mobile devices. Studies have reported that students have had no Wi-Fi access in the hospital or there have been dead spots in the network coverage. This has resulted in an inability to access the Internet and digital materials and consequently frustration among students (12,15). Furthermore, many hospitals have regulated the use of personal mobile devices through formal policies, thereby hindering the open use of devices (2). Previous studies have suggested that medical students and junior doctors seek reliable medical mobile resources (15,16) and would like senior colleagues to share with them quality online resources in their field.

In 2013, the Faculty of Medicine at the University of Helsinki began to deliver tablet computers to first-year medical and dental students for their personal study use. The iPad action research project has followed medical and dental students' use of iPads since then, collecting data on all new student cohorts and followed their mobile device use in both their pre-clinical and clinical studies (17). Therefore, an opportunity presented itself to explore the student cohorts' device use both vertically, following

the development of a cohort during their study years, as well as horizontally comparing the device use of different student cohorts at certain stages of their studies. Our search of the literature has not discovered a similar longitudinal study.

For five years, the project followed the first cohort of medical and dental students who were delivered iPads for their personal study use in 2013. Already during the autumn of 2013, it was discovered that students needed support to learn to use these devices for educational purposes, and this was organized along with course-based support for faculty the very same autumn. Most of the students were persistent in learning to use the new device as a study tool (17). Digital note taking was along with online information seeking the most important use of mobile devices in students' studies (18).

In the project so far, one of the key findings was that when the first medical cohort commenced clinical studies in the spring of 2016, a noticeable drop in their iPad use occurred, specifically in note taking and retrieval, use of digital learning materials (e.g. eBooks) as well as pre-class triggers and tests. Nonetheless, growing importance of online information resources for students was observed in the form of them valuing instant access to online information resources. For this purpose, they mostly used their personal smartphones. In patient encounters students reported not using the iPads. This was a surprising finding given the previous two preclinical years' active use of the device and investment into a personal digital library. The students in the first iPad cohort also reported resistance towards the usage of iPads as they entered clinical studies. Altogether, both the previous literature and our study of the first cohort of medical students reported challenges in incorporating the devices into the clinical setting (13,16,17).

2 Aim of the study

In this study, we sought to identify challenges and impediments to be overcome in the clinical setting in order for us to discover feasible ways of using mobile devices, ways to make the most use of the potential of the new technology in the hands of future healthcare providers, and to assess whether measures taken to tackle specific problems were effective. We sought to answer the following questions: (1) How did the students assess their own and their clinical teachers' ability to use iPads in learning and teaching? (2) How did the clinical pre-class and in-class assignments support the students' use of the new technology? (3) How did students use the mobile device with the patients?

3 Material and methods

To explore hurdles in the adoption of iPads in the clinical phase of medical studies, we scrutinized the online survey collected of the three consecutive student cohorts entering the clinical studies and focused on the closed-ended questions on the in-class digital teaching and learning and the use of iPads in teaching involving patients.

3.1 Context of the study

The context of this study was the medical degree programme at the Faculty of Medicine, University of Helsinki, Finland. The medical programme admits new students every autumn along with the dental programme. The first two years focus on biomedical studies and are almost identical for medical and dental students. Students study these topics in mixed programme groups through problem-based tutorials and lectures. In the third year, medical and dental students continue their clinical studies separately. The clinical portion of the medical studies includes lectures, small group - teaching, skills lab exercises, bedside teaching and hands-on clinical learning. The

medical programme rewards the title of Licentiate of medicine, qualifying graduates to practice medicine in Finland.

3.2 Participants

The three cohorts studied consist of iPad-equipped 3rd year medical students which commenced their medical studies in 2013, 2014 and 2015, and further started their clinical studies in the spring of 2016, the autumn of 2016 and the autumn of 2017 respectively. The studied cohorts received personal iPads as part of a digitalisation project of the Faculty of Medicine during the first days of their preclinical studies, for use in studies and privately. Before the term of 2016-2017 the clinical phase of studies traditionally commenced during the spring term of year 3 but was then shifted to start at the beginning of year 3 due to a revision of curriculum. This study analysed responses given by the cohorts at the end of their respective first semester of clinical studies.

Basic information on cohorts, including the number of students per cohort, response percentages and sex of respondents were also gathered and are presented in the Results.

3.3 Research ethic and consent to participate

When the research project began in 2013, there was no research ethics committee dedicated to educational research in the Faculty of Medicine at the University of Helsinki. Therefore, ethics committee approval could not be granted before the research started and could not be obtained retrospectively. However, the research was carried out in accordance with the guidelines of the Declaration of Helsinki and the Finnish National Advisory Board on Research Ethics.

All students were informed upon picking up their iPad that the use of iPads would be a focus of research. Participants were informed by email of the purpose of the questionnaires and contact information of the principal investigator (EP). Partaking was voluntary and an electronic informed consent was inquired. The principal investigator (EP) oversaw data collection and anonymisation of the data. This was particularly important because the leading author (DF) was a student from one of the student cohorts studied. Confidentiality and anonymity of respondents were guaranteed throughout the research and publication processes.

3.4 Data collection and analysis

The data were collected with online surveys (E-lomake©) which identified students by their university login credentials. The survey included closed-ended (multiple choice and 5-point Likert scale questions) statements and open-ended questions on the study use of mobile devices. There were no suitable validated questionnaires available on review of the literature. The questionnaires were developed from themes arising from the literature and the teaching and learning practices in our unit. The questionnaire was originally in Finnish. The translation of the questionnaire is provided in the Supplement.

This study analysed responses given by the cohorts at the end of their respective first semester of clinical studies. Multiple reminders per survey were sent to each study year's mailing list in order to maximize the degree of participation.

Duplicate answers by students were checked cell by cell and the latter duplicate was deleted in the raw data. Answers stored through the electronic questionnaire service were exported to Microsoft® Excel and anonymized through deletion of student identification codes by EP. The closed-ended questions were analysed using Microsoft®

Excel for Mac version 16.22 by calculating the frequency distributions of the answers for the statements and comparing the results between the three cohorts.

4 Results

The response rates for the surveys were satisfactory, 90.83% for the first cohort, 70.83% for the second cohort and 67.50% for the third cohort (Table 1). The response rates of female and male students correspond to their portion of the whole student cohort. The first two cohorts were comprised of 120 medical students each, while the 2015 intake was 150.

Table 1. The response rates of the three third year medical student cohorts in the years 2016, 2017 and 2018.

	Total	Female	Male
1st cohort in 2016 (N=109)	90.83 %	57.90 %	42.10 %
2nd cohort in 2017 (N=85)	70.83 %	54.12 %	45.88 %
3rd cohort in 2018 (N=81)	67.50 %	56.80 %	43.20 %

When the 2016 cohort started their studies in 2013, 80.50% of the respondents had a smartphone and 23.80% had in addition to the iPad another tablet computer whilst 80.20% had a laptop (Table 2). The adoption of the smartphone is obvious in the subsequent cohorts with almost all students owning one in the 2018 cohort. Tablet computers also became increasingly common, one third of newly accepted students owning one by 2015. Meanwhile the incidence of laptops amongst new students saw a small decline from 2013 to 2015.

Table 2. The students' own devices at the beginning of their studies expressed as percentages.

	Smart phone	Tablet computer	Laptop computer
1st cohort in 2013	80.50%	23.80%	80.20%
2nd cohort in 2014	92.10%	23.80%	80.20%
3rd cohort in 2015	99.00%	34.60%	76.40%

4.1 Students' and teachers' ability to use iPads in learning and teaching

In their third year of studies, the students were accomplished users of mobile devices for educational purposes. Students were asked to rate their own ability to use the mobile device for studying and subsequently rate their clinical teachers' ability to use the iPad in teaching. Students' generally rated their own ability of using the iPad in studies as good, the incidence of reported excellent usage doubling for the latter two cohorts (Figure 1a). Reports of lacking or poor ability to use the iPad in studies was almost non-existent. The 2016 cohort deemed only 7.3% of teachers to use iPads for teaching in a good or excellent fashion, and 43.1% to do so inadequately or not to be able to use them at all (Figure 1b). Subsequent cohorts reported increasing rates of good usage of the iPad by teachers, also fair usage seeing a notable increase. The reported rate of very poor usage decreased markedly after the initial cohort.

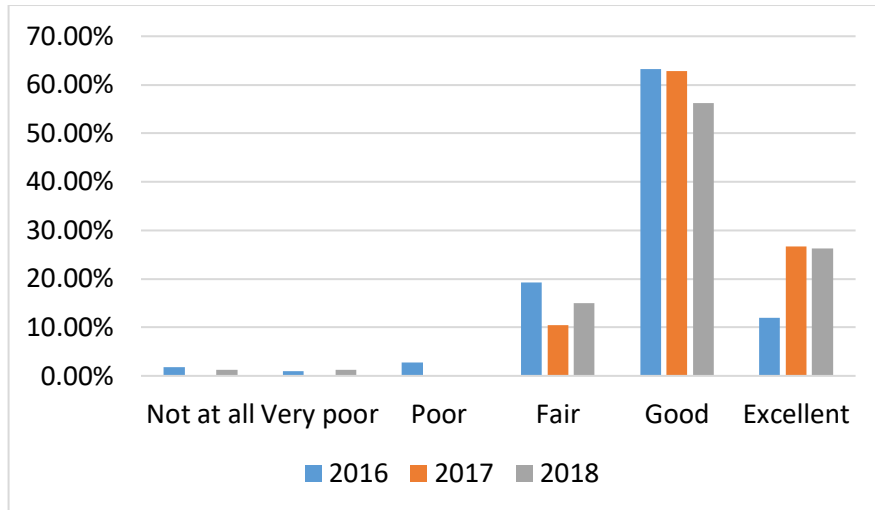


Figure 1a. Students' own ability to use the iPad in studying

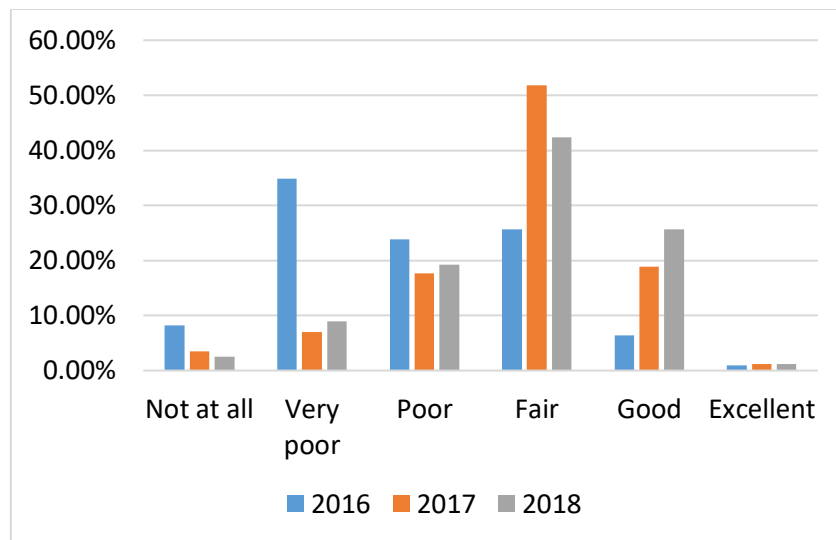


Figure 1b. Teachers' ability to use the iPad in teaching

4.2 Distribution and format of study materials

To effectively use mobile devices for note taking, students needed to download teachers' handouts before class in a suitable PDF format. When the materials were not delivered in time or in the right format, the students were not able to annotate the materials.

Therefore, we asked the students about utilization of electronic study materials. 75% of the 2016-cohort reported teachers to upload handouts before class quite often, similar responses being given by the latter two cohorts (Figure 2a). 18% of the 2016 cohort thought teachers to do this quite seldom with a steady decline in latter cohorts. The number of students reporting study materials always to be uploaded ahead of class increased notably in the last cohort, the absolute number however still being low.

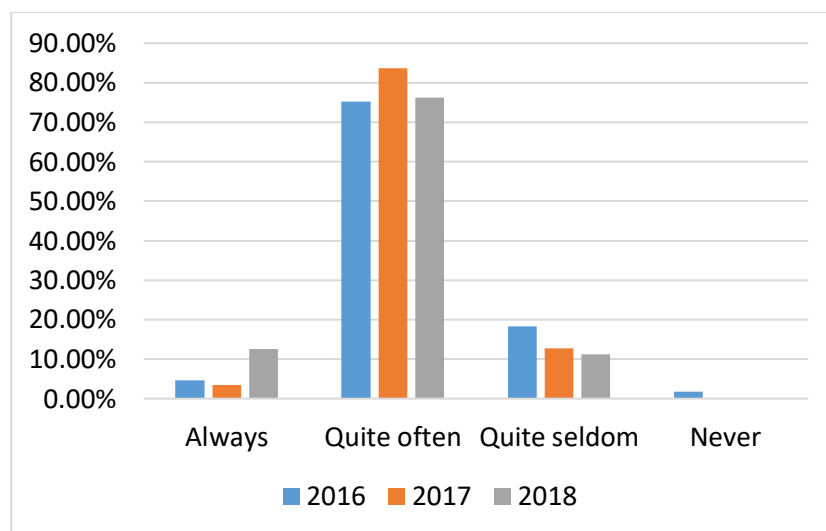


Figure 2a. Teachers uploading of handouts before class in e-learning environment

The majority of the 2016 cohort reported the PDF format to be used quite often, subsequent cohorts reporting similar rates (Figure 2b). Only a fraction of the 2016 cohort thought teachers to do this quite seldom, the incidence decreasing with subsequent cohorts. A noticeable finding is that 15% of the 2018 cohort thought teachers to do so always, an increase from previous two years corresponding answers being only 7% and 8%.

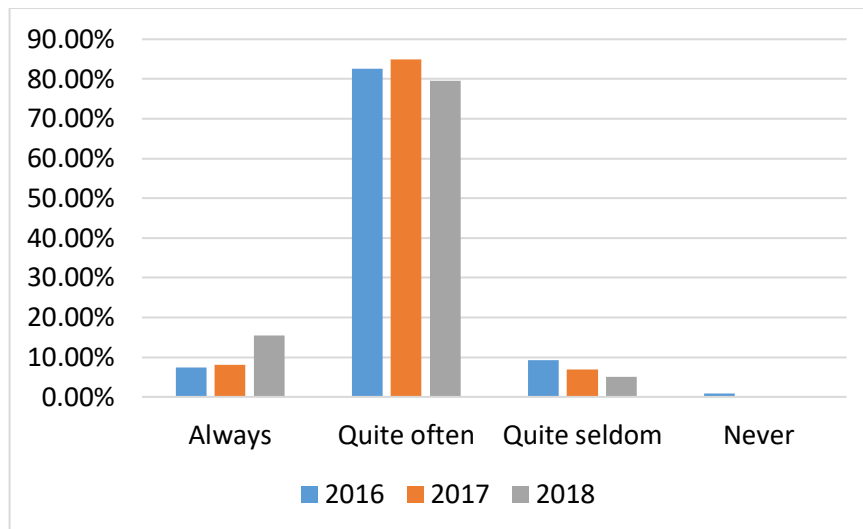


Figure 2b. Teachers' uploading of study materials in the PDF format

4.3 Use of mobile device-compatible pre-assignments

Along with delivering the mobile devices to students and teachers, the Faculty of Medicine encouraged teachers to provide students with versatile digital pre-class assignments to activate their prior knowledge and offered courses on making educational videos for the courses they taught. We asked the students to evaluate how the pre-assignments were implemented in their studies.

A majority (67%) of the 2016-cohort reported teachers to use tests for pre-assignments quite seldom, the number rising (71% and 76% respectively) with the following cohorts (Figure 3a).

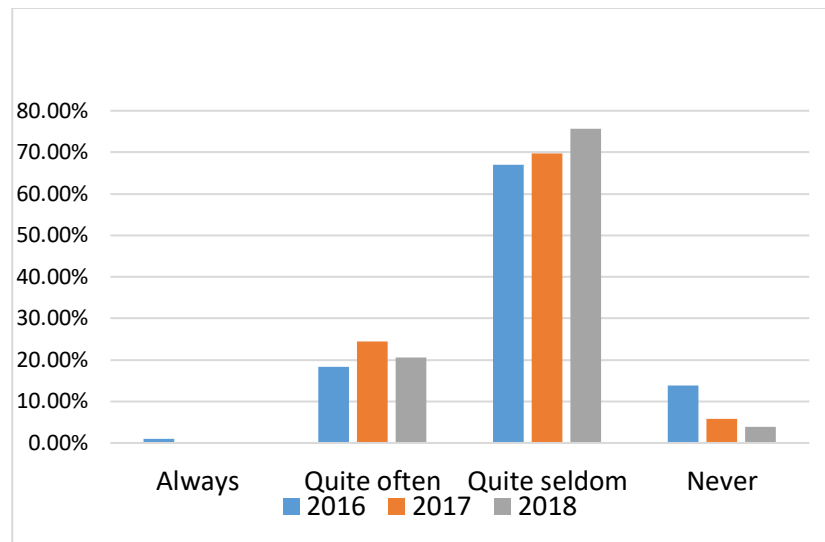


Figure 3a. Teachers' use of tests for pre-assignments

Videos were used for pre-assignments quite often according to only a fraction (8%) of the 2016 cohort, reported rates rising to 19% and 26% with the subsequent cohorts (Figure 3b). Over three quarters (78%) of the 2016 cohort thought videos to be used quite seldom with similar response rates in the subsequent cohorts.

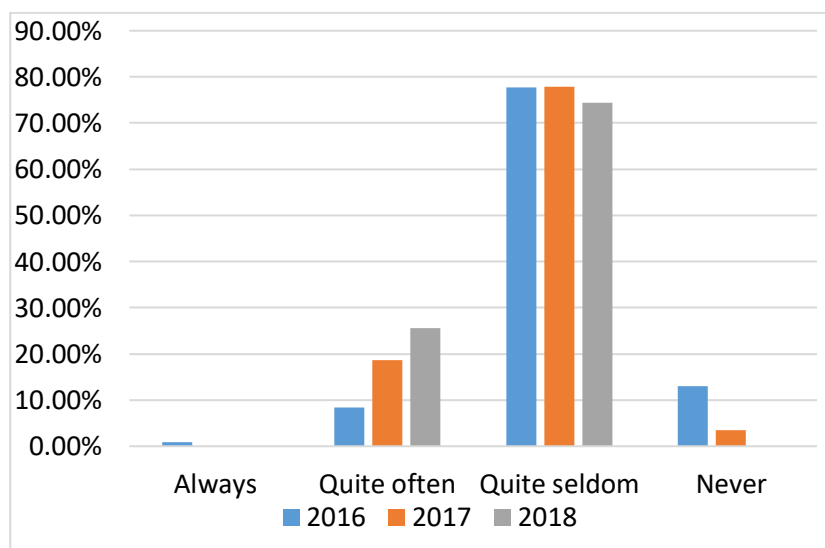


Figure 3b. Teachers' use of videos for pre-assignments

Increasing numbers of students (7% (2016), 15% (2017) and 27% (2018)) reported pre-assignments used as being mobile device compatible, whilst a decreasing number (17% (2016), 7% (2017) and 5% (2018)) thought them to be so quite seldom (Figure 3c).

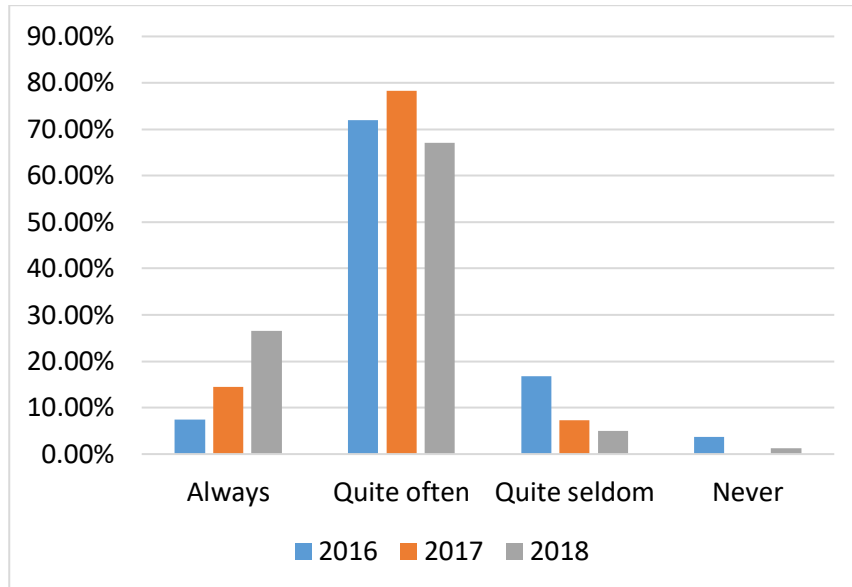


Figure 3c. Mobile compatibility of pre-assignments used by teachers

4.4 Use of in-class triggers and applications

Students' mobile devices enable teachers to use online triggers, such as tests, votes and tasks in class. Only a mere 12.6% of the 2016 cohort reported teachers to always or quite often use this type of trigger in class for enhancing learning, subsequent cohorts however reporting markedly increasing rates (30.6% and 39.7%, Figure 4a). Respectively, a clear majority of the first cohort (73.2%) thought teachers to do so quite seldom, subsequent cohorts reporting a continuous decrease 68.2% (2017) and 56.4% (2018).

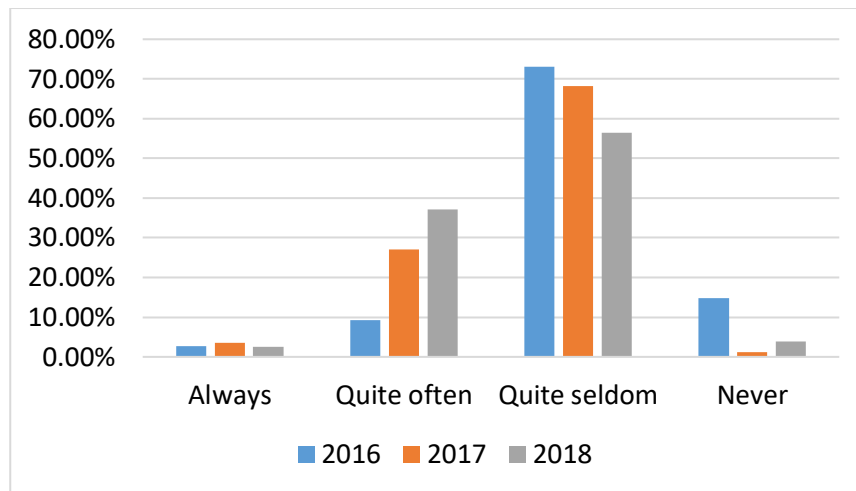


Figure 4a. Teachers' use of in-class triggers (voting, tests and tasks)

A considerable number of resources and applications designed for medical education are available in application stores. The survey showed that teachers seldom (48% (2016), 49% (2017) and 54% (2018)) or never (42% (2016), 47% (2017) and 41% (2018)) told students about apps relating to their clinical field, results staying similar throughout all studied cohorts (Figure 4b).

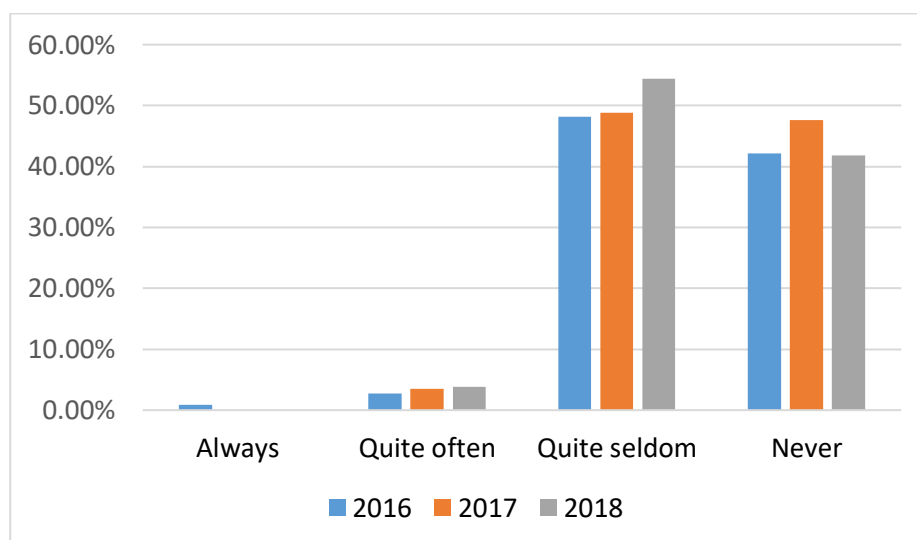


Figure 4b. Teachers relating of quality mobile device applications to students

4.5 Students use of iPads in studies

Digital note taking and online information seeking were the most important study uses of mobile devices among these students in the preclinical study years. Note taking on mobile devices in the clinical phase saw a non-linear development with the majority doing so always or often (Figure 5a).

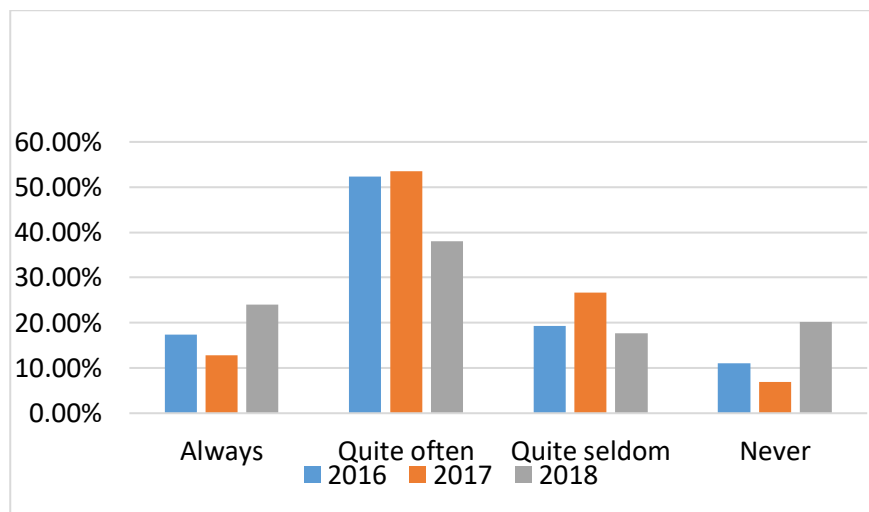


Figure 5a. Students' use of mobile devices for taking notes

The incidence of students reporting always using mobile devices for seeking information saw almost a doubling after the first cohort, whilst the majority reporting doing so quite often remained at a constant level (Figure 5b). Those reporting using mobile devices for seeking information quite seldom saw a steady increase whilst still remaining only a fraction of the respondents.

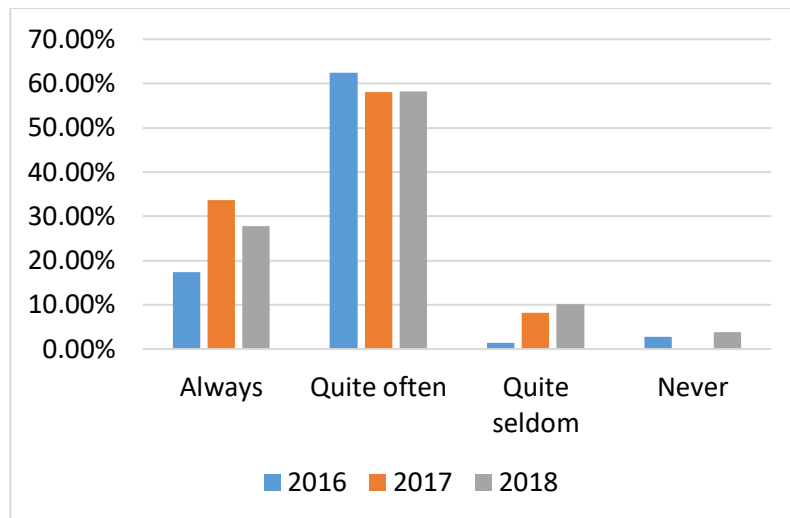


Figure 5b. Students' use of mobile devices for seeking information

We found that a majority of students reported seldom or never using mobile devices for retrieving learning materials and taking notes in the skills lab (Figure 5c). The fraction of students reporting to always use mobile devices in the skills lab for this purpose decreased with subsequent cohorts, those doing so quite often remaining at a fairly steady state.

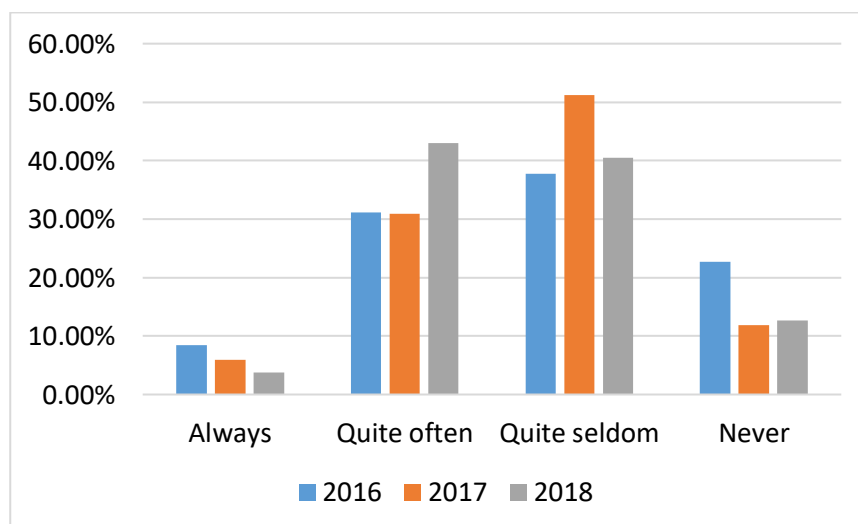


Figure 5c. Students' use of mobile devices for retrieving learning materials and note taking in the skills lab

4.6 Students' use of mobile devices with patients, and the remedies they suggested for improving it

Use of mobile devices with patients for enhancing communication was sparse and on the border of nonexistent with 10% of the 2016 cohort reporting quite seldom usage and 87% reporting never using mobile devices for this purpose (Figure 6a). Subsequent cohorts reported very similar numbers.

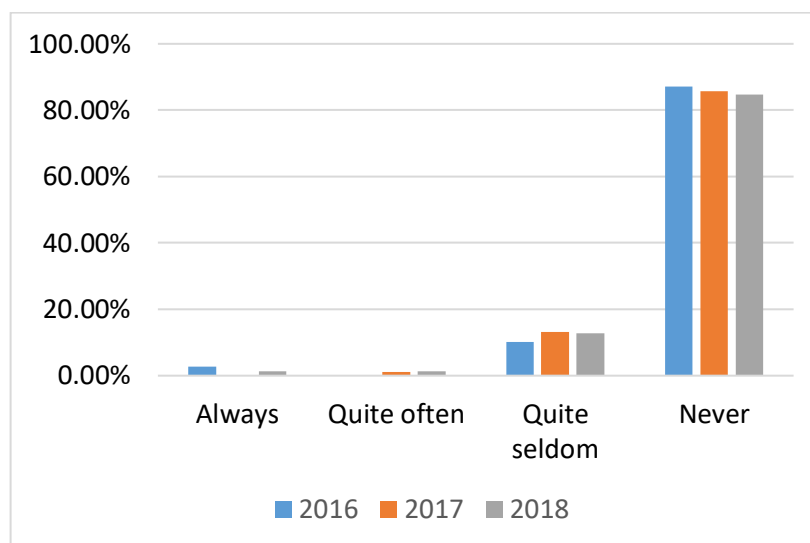


Figure 6a. Students' use of mobile devices with patients to enhance communication

A mere fraction of students reported always using mobile devices for supporting clinical reasoning. 19% of the 2016 cohort students reported using a mobile device quite often for supporting clinical reasoning, latter cohorts reporting varying rates (Figure 6b). A total of 44% of the 2016 cohort reported seldom usage with latter cohorts' rates varying. Roughly a third of the 2016 cohort and later slightly higher numbers of students reported never using a mobile device for clinical reasoning.

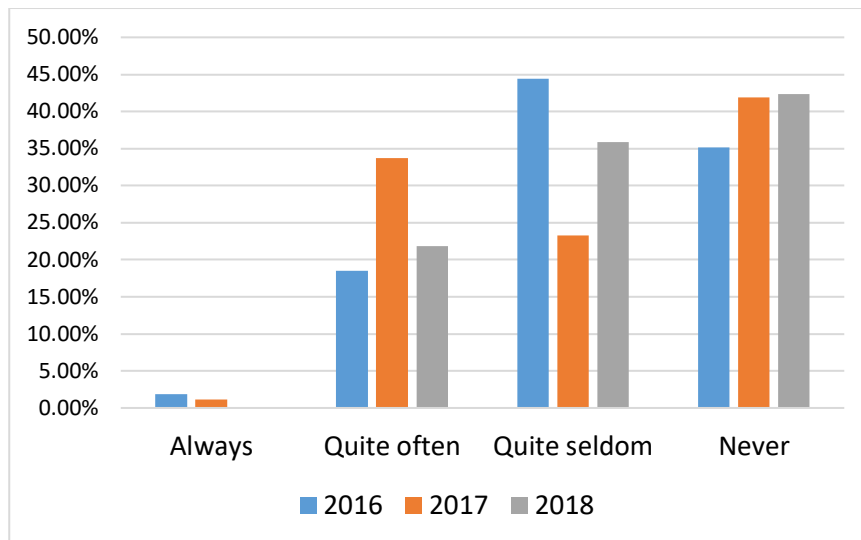


Figure 6b. Students' use of mobile devices to support clinical reasoning

4.7 Use of patient records on mobile devices

The privacy of patients and the security of their information is pivotal in healthcare. The majority of students through each cohort reported never using mobile devices for taking notes of patient records (Figure 7a). The majority also reported always deleting any patient records stored on the device (Figure 7b), with around a fifth of students reporting never to do so. The decision not to store patient records on cloud services was almost unanimous with close to all respondents reporting never to do so (Figure 7c).

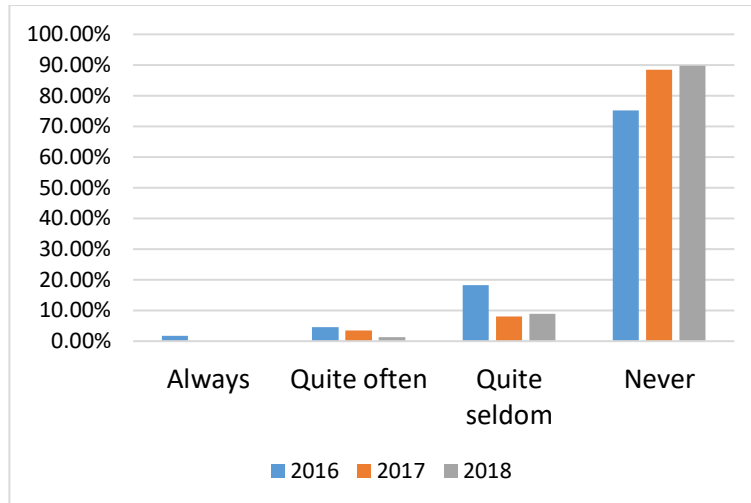


Figure 7a. Students take notes of patients records with a mobile device.

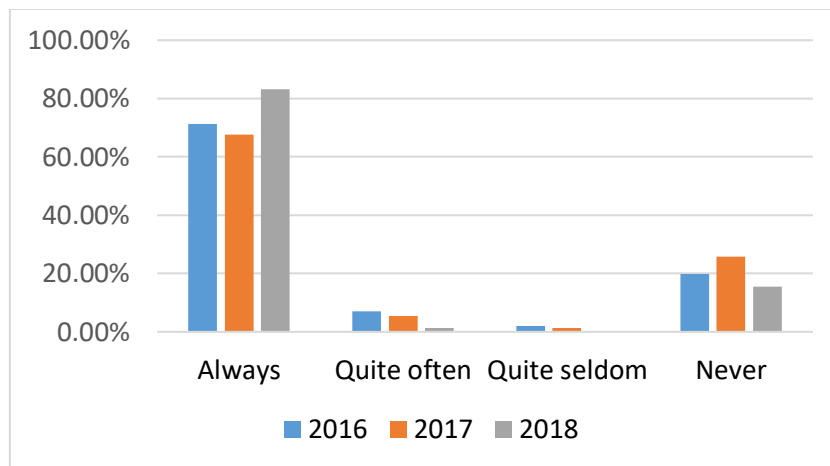


Figure 7b. Students delete the patient records from their mobile devices.

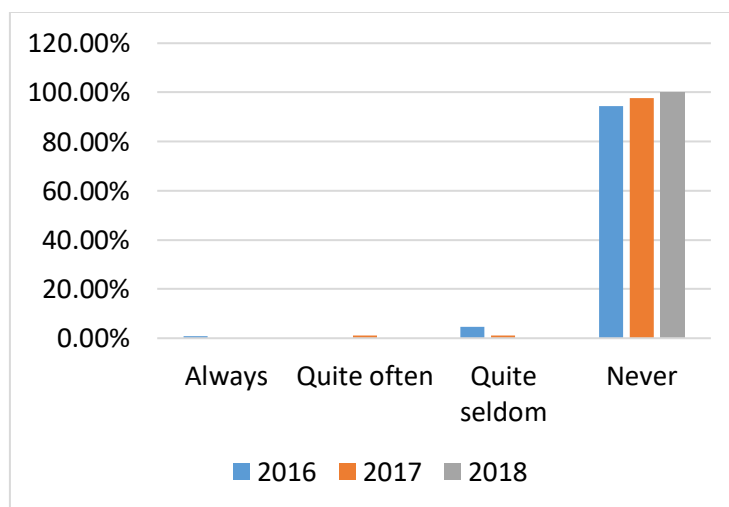


Figure 7c. Students save patient records to the cloud.

The risk for transmission of infection requires attention when adopting mobile devices in healthcare. Students reported taking into account the risk of infection more often than not (Figure 7d), 71% (2016) reporting to do so always or quite often, with corresponding figures for the subsequent cohorts decreasing slightly but staying above 60%.

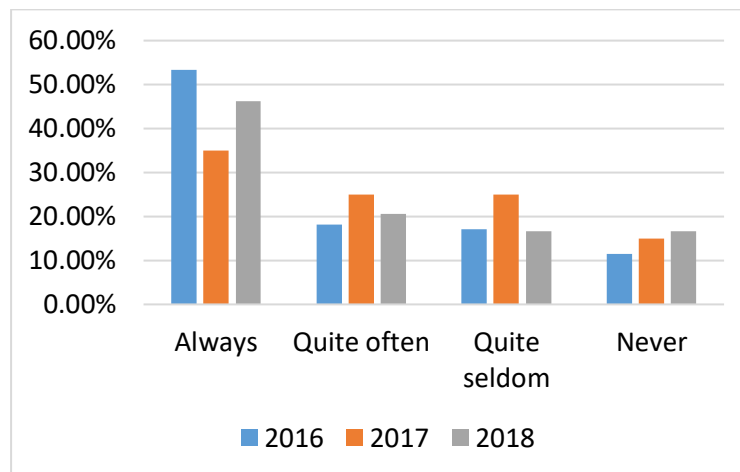


Figure 7d. Students take into account the risk of infection when using a mobile device

5 Discussion

The goal of this study was to explore hurdles in the adoption of iPads in the clinical phase of medical studies, as well as to examine differences in problems faced by the three consecutive years of iPad-cohorts entering clinical education. This was to get an idea of how well the clinical environment was receiving the iPads and if measures taken to tackle specific problems were effective.

Response rates for the first cohort in 2016 were a staggering 90%, suitable to the novelty of the use of iPads in the clinical setting. Decrease in the response rates with subsequent cohorts is likely due to questionnaire fatigue. Reported incidence of mobile phones, tablets and laptops with new students at the beginning of their studies largely mirror overall adoption of increasingly more mobile technology in the general population.

Our findings are notably consistent with previous findings. Medical students benefited of using the devices especially for searching information and medical resources on the Internet (1-4). Our study showed similar declining tendency in note taking as previously reported (14,18). Use of the devices for information seeking on the other hand increased markedly after the first cohort. This could be due to a general routine in device use forming and the knowledge of processes being handed down to the new generations by both faculty and senior student colleagues.

Furthermore, we observed that the mobile device use in direct patient contact raised serious concerns among students. Students were hesitant in using the device with the patients in fear of a deteriorating effect for the communication with the patient (2,7,13,14). Students' ambivalence in the device usage was partly due to previously reported social barriers of fearing that their online information seeking being interpreted as unprofessional behaviour by senior doctors and other healthcare professionals (13,14). The few studies exploring the patients' own perceptions of the usage of mobile devices at bedside reported positive attitudes among patients (6,10,12). At this stage of our project, we did not have data on the patients' point of view.

Previous studies reported that poor Wi-Fi access and therewith problems with accessing the Internet and the digital learning materials in the clinic were major

barriers to benefiting of mobile devices in clinical studies (12,15). In our study, students mostly complained about the disorderly online learning environment where the learning materials were delivered too late and/or in a non-suitable format for note taking. Teachers rarely incorporated digital pre-class or in-class assignments into the clinical courses, and finally several students left the iPad at home. When we compared the results between the three cohorts entering the clinic, there was a slight positive trend towards more active use of the digital learning environment and better reception of the mobile-savvy students in the clinical context along the years.

We observed an eminent mismatch in the students' self-reported ability to use iPads for studying and their perception of the teachers' ability to apply these devices for teaching. Both the teachers' as well as the students' ability to use the iPad for clinical teaching and learning improved with subsequent cohorts. As more experience was garnered among faculty it is reasonable to believe their ability to aid students in maximizing the use of the device also strengthened. The comparison between the three cohorts showed that despite the improving practices and attitudes among the teachers, the teachers' ability to effectively apply the digital environment and accept the students' mobile devices improved relatively slowly. This points to the weight of giving faculty sufficient training in the use of novelty technology. On the other hand, some pre-existing skills were always available to draw on, as was evident with teachers' distribution of learning materials electronically and in suitable format. These were habits fostered by earlier movement towards an electronic curriculum which was largely desktop and laptop computer-driven, and were skills inherited for the benefit of a more mobile electronic curriculum. The use of pre-assignments would logically follow much the same route; our results turned up with fairly seldom use of them but at least when used they were generally compatible with mobile devices. Also, the use of in-class triggers was generally rare but developed over time with subsequent cohorts to noticeable use.

An important finding of this study was the fact that practically no students seemed to use the iPad for backing up clinical reasoning. This despite a majority reporting using it for seeking information. The results may be in part explained by difficulties in interpreting the questionnaire statements. Some students might also be unfamiliar with the concept of clinical reasoning so early in their clinical studies.

Another noteworthy finding lies in the mobile devices use for taking patient records. Whilst students almost unanimously reported never taking patient records with their mobile devices, ca 20% of students from each cohort reported never deleting patient records from their device. The discrepancy in reporting of taking patient records and deleting of them suggests that either more students used their iPad for taking patient records than cared to admit it in the questionnaire, or some students simply felt like they wouldn't delete patient records if they took them using their iPad. The possibility of difficulty interpreting the question also remains, with students in the Helsinki medical faculty more rarely taking patient records independently as opposed to interviewing patients as a group as part of bedside teaching or filling in a pre-existing printed paper form for interviewing and examining patients.

Mobile devices are in themselves powerful devices even using only a web browser. The mobile breakthrough has however much been due to development of a myriad of applications for the devices. In accordance with previous studies (15,16), our study showed that the teachers communicated very little information to students about suitable and quality medical applications, despite these not being unheard of. These results remained similar throughout the three cohorts. Again, the novelty of mobile devices in clinical teaching would make for the most reasonable explanation but at the time of writing, there were over one thousand reviewed medical apps available for the iPad only (imedicalapps.com search 28.3.2019), begging the question of why so few clinical teachers seem to recommend or even use apps as part of their practice.

5.1 Strengths and weaknesses of the study

The strength of this study is found in part in the duration of the iPad research project, having started in 2013 and information having been gathered on all subsequent student cohorts until the present. We've yet to discover in the research literature a similar study following medical student cohorts in their mobile device usage throughout their study years. Furthermore, a total of three cohorts were analyzed for this study, yielding an oversight of the development of the studied aspects from introduction through more routine use. The response rates of the study were satisfactory. With the lead author being a student of one of the studied cohorts also unique insight into the studied phenomenon was utilized. The research project has actively collaborated with both students and faculty, yielding benefits from the iterative process. This study delivers on previously identified topics of interest reported by earlier studies presented in international conferences and published in reviewed articles (17,18).

This study is limited in some respects. Questionnaire questions were not validated since at the time the research project started, there were no validate questionnaires concerning mobile learning. Furthermore, one limitation was that it was performed at a single institution. The novelty of the iPads in clinical studies also, while yielding a trend, did not show a plateau phase in the different areas of use with the three cohorts studied. However, when studying the existing literature, we thought that a more detailed study on students' perceptions of the hurdles in adopting the mobile device usage in the clinical context would provide useful information for the units incorporating new technology in their teaching.

5.2 Future directions

A large amount of both quantitative as well as qualitative data has been collected as part of the iPad research project from 2013 through 2019. The next step is to analyze the students' answers to the open-ended question using qualitative content analysis. Further topics to look into will be patients' perception of the use of mobile devices in clinical encounters, students' use of social media and the mobility of learning.

5.3 Conclusion

There were three main findings related to the hurdles for adopting mobile learning devices at the outset of the clinical studies. First, there was a mismatch in the students' and teachers' ability to apply the mobile device in teaching and learning. Second, the digital learning environment did not support mobile note taking nor other use of novel technology in the students' first clinical study year. Third, the ambivalence related to the usage of the mobile device in patient contact was twofold. Students themselves hesitated to use the devices with patients and also feared the attitudes of the senior colleagues and other healthcare professionals towards their device use. Taking into account these aspects would benefit the utilization of the full potential of mobile devices in clinical studies, making way for incorporating them and making the most of their benefits in future patient care.

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Supplement

Message to the students and the questionnaire translated into English

Message to the students

Dear medical/dental student,

The Faculty of Medicine provided you with iPads for personal study use in 2013. The Faculty established an iPad research group for developing the study use of iPads in medical and dental studies in our faculty. The iPad research group invites you to give information about the study use of iPads to improve the study use of these devices.

You are our best experts in the use of mobile devices for studying. We wish you to answer a questionnaire concerning your personal study use of the device in medical/dental studies.

Answering the questionnaire is voluntary. The answers will be treated confidentially and anonymity is guaranteed throughout the analysis and the report of the results.

You can answer the questionnaire by using the following online format. Remember to send your answers by pressing the end command at the end of the questionnaire.

<https://elomake.helsinki.fi/lomakkeet/1234/lomake.html>

We recommend you fill in the online format in a place where the wifi is stable.

Your response is valuable to us!

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Questionnaire: iPads in the Faculty of Medicine, 3rd year medical/dental students

The study use of tablet computers in medicine/dentistry is a large project started in the Faculty of Medicine in 2013 to support students' learning. Now you are on your 3rd study year and have already started your clinical studies. The aim of this questionnaire is to gather information about your personal study use of mobile devices in the clinical context and to provide us with ideas to improve the use of these devices.

By answering this questionnaire, you can help us develop the teaching and learning practices!

Background information

Student number _____

The year of birth, e.g. 1990 _____

Gender

Choose the gender

Female

Male

Programme

Choose the study programme

Finnish speaking

Swedish speaking

Do you have prior academic studies?

No

Yes

If you have prior academic studies, tell us what you have studied and how extensive your studies have been (study credits and possible degrees) _____

Students' and teachers' ability to use the iPad

Assess your own ability to use the iPad in your studies at present

Not at all
Very poor
Poor
Fair
Good
Excellent

Assess the clinical teachers' ability to use the iPad in teaching

Not at all
Very poor
Poor
Fair
Good

Mobile devices and digitality at the clinical stage of studies

Learning materials

Teachers upload lecture handouts and other learning materials before class in the digital learning environment

Always
Quite often
Quite seldom
Never

Teachers upload the materials in the Pdf format

Always
Quite often
Quite seldom
Never

Teachers use tests for pre-assignments

Always
Quite often
Quite seldom
Never

Teachers use videos for pre-assignments

Always
Quite often
Quite seldom
Never

The pre-assignments teachers use are mobile device compatible

Always
Quite often
Quite seldom
Never

Teachers tell the students about quality mobile device applications in their clinical field

Always
Quite often
Quite seldom
Never

How could the use of digital learning materials be developed in clinical teaching?

Studies and instruction

In class, I use mobile devices for taking notes

Always
Quite often
Quite seldom
Never

In class, I use mobile devices for seeking information

Always
Quite often
Quite seldom
Never

In the skills lab, I use mobile devices for retrieving learning materials and note taking

Always
Quite often
Quite seldom
Never

In class, teachers use triggers for learning, such as voting, tests and tasks

Always
Quite often
Quite seldom
Never

How could the use of iPads be developed in clinical teaching?

Mobile devices in encounters with the patients

I use the mobile device with patients in a way that enhances communication with them

Always
Quite often
Quite seldom
Never

I use the mobile device to support clinical reasoning

Always
Quite often
Quite seldom
Never

I use the mobile device to support patient safety

Always
Quite often
Quite seldom
Never

I take notes of patient records with a mobile device

Always
Quite often
Quite seldom
Never

I delete the patient records from my mobile device

Always
Quite often
Quite seldom
Never

I save patient records into the cloud

Always
Quite often
Quite seldom
Never

When I use a mobile device, I take into account the risk of infection

Always
Quite often
Quite seldom
Never

How could the use of iPads be developed in bedside/chairside teaching with patients?

Assessment

Teachers offer study module entrance exams suitable for mobile devices

Always
Quite often
Quite seldom
Never

Teachers offer tests during the study module suitable for mobile devices

Always
Quite often
Quite seldom
Never

Teachers offer course exams online

Always
Quite often
Quite seldom
Never

How could iPads be better used in assessment for and of learning?

Use of social media in studies

I use social media for delivering information

Always
Quite often
Quite seldom
Never

I use social media for arranging affairs pertaining to studies

Always
Quite often
Quite seldom
Never

I use social media for sharing learning materials and resources

Always
Quite often
Quite seldom
Never

I use social media for groupwork

Always
Quite often
Quite seldom
Never

Describe in your own words, how the use of the social media supports your studies

Would you like teachers to be members of the students' social media groups?

Yes

No

How could social media better be used in clinical studies?

Study applications and medical applications

What study applications (for example note taking, sharing) do you use?

What medical applications do you use?

What medical applications have your teachers recommended you?

Studying and learning

I print learning materials

a lot

sometimes

not at all

I prefer reading course literature

as an e-book

as a printed book

I don't read course literature

When I study, I use at the same time (you can choose several options)

- a printed book
- e-book
- my own notes
- somebody else's notes
- iPad
- Internet
- lecture materials
- dictionary
- other

If you answered other, what do you refer to? _____

When I study for an exam, I use at the same time (you can choose several options)

- my own notes
- somebody else's notes
- summaries made by the teacher
- publicly available summaries
- a text book
- other

If you answered other, what do you refer to? _____

When I study for an exam, I prefer studying

- alone
- with my close peers
- with my teaching group
- otherwise

If you answered otherwise, what do you refer to? _____

Consider your studying and learning and answer the following statements

I believe I will do well in my studies

- Fully disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Fully agree

I am certain I can understand the most difficult material in my studies

- Fully disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Fully agree

I am confident I can understand the basic concepts
of my own field of study

Fully disagree
Somewhat disagree
Neither agree nor disagree
Somewhat agree
Fully agree

I expect to do well in my studies

Fully disagree
Somewhat disagree
Neither agree nor disagree
Somewhat agree
Fully agree

I'm certain I can learn well the skills required in my
field of study

Fully disagree
Somewhat disagree
Neither agree nor disagree
Somewhat agree
Fully agree

I believe that I will easily learn the use of the
technical devices I need at work

Fully disagree
Somewhat disagree
Neither agree nor disagree
Somewhat agree
Fully agree

Learning to use technical devices

I learn to use technical devices

___ by watching videos

___ by taking a course

___ by asking a friend

___ in another ways

If you answered in another way, tell us about it _____

I use iPad for studying (you may choose several options)

___ before leaving for school

___ on my way to school

___ between the classes

___ after the school day is over on campus

___ in the campus library

___ on my way home

___ at home after the school day

___ in the evening at home

___ elsewhere

If you answered elsewhere, tell us more about it _____

Describe your three most important study uses of iPads

1. _____
2. _____
3. _____

Consent to participate in the study

We hope that we can use the answers of this questionnaire in a study about the use and effectiveness of the tablet computers and are able to combine the answers with student records and consequent questionnaires of the iPad research project. Full confidentiality and anonymity in the analysis and reporting of the research material are guaranteed.

I give my consent for using the answers given in this survey in a study and collate the answers with my student records and consequent questionnaires of the iPad research project.

Consent

Yes

No

Thank you for answering the questionnaire!

Inquiries concerning the research and the questionnaire:

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Remember to press the 'send' button at the end of the webpage.