Report 1

Key Factors for Successful Digitalization of Practice-based Learning in Healthcare Higher Education

Digitalization in learning practice placement

Co-funded by the European Union

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Title: Report #1 on Key Factors for Successful Digitalization of Practice-based Learning in Healthcare Higher Education

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This report was created by the 4D project.

The 4D project (4D in the digitalization of learning in practice placement) is an EC-funded project aimed at introducing mobile technology in practice placements, creating a bridge between the different actors involved learning contexts to foster the best experience in practice-based learning in healthcare settings. Our multidisciplinary team uses qualitative, quantitative, and design methods to help European universities interested in introducing mobile applications in practice placements. We strive to design the best mobile app proposals based on input from various stakeholders, including students, clinical and academic tutors, managers, and others from different contexts such as universities and centers of practices.

Digitalization in learning practice placement

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Content

To address actual problems in teaching as well as learning, embed technologies in respective practices and increase acceptance, the Technology Enhanced Learning (TEL) solution(s) must be co-designed with affected researchers, teachers, students and administrative staff.

Executive Summary of the Report

Background

Introducing mobile technology into clinical education in practice placements has the potential to enhance the learning experience, improve knowledge retention, and develop clinical skills, while providing a cost-effective solution for clinical education programs. However, the learning process in clinical settings involves several actors such as tutors, supervisors, teachers, and students, and during this complex process, tasks and mentorships must be done in a way that is synchronized with educational and clinical processes.

Aim

The aim of this report is to describe the key factors of the different models and theories in practice-based learning (centers, different actors, processes) and to identify the main elements that need to be considered in the process of introducing mobile technology into practical education in a clinical environment. Specifically, identifying and analyzing the main facilitators and barriers, and discussing the needs and perspectives of health care students and stakeholders involved in clinical education. In order to give response to the main aim of this report, a literature review and focus groups with healthcare students and stakeholders involved in practical education were conducted.

Results and outcomes

Our results found many facilitators but also some areas of concern when introducing mobile technology into clinical education in practice placements. Positive attitude towards mobile applications, improving the quality of clinical education, managing the learning process enhancing cooperation and communication, increasing the quality of care and other benefits for patients are some of the main facilitators. In contrast, lack of clear regulations and guidelines for using mobile technology in clinical settings, low cultural acceptance of using mobile devices for scientific and educational purposes, concerns about confidentiality, privacy and patient security, technical issues, costs and inadequate infrastructure and barriers related to information literacy, digital competences, and students' and mentors' skills are the main challenges that need to be addressed.

From this, we have distilled several key areas that have to be taken into consideration to co-Design a mobile learning application (app) for successful adoption of mobile technology in practice-based learning reflecting users' core values and needs and to ensure a successful digitalization of practice-based learning in healthcare higher education. By addressing the challenges and leveraging the facilitators, educators and other stakeholders can develop effective and innovative digital learning strategies that can enhance the quality of healthcare education.

Mobile learning is becoming increasingly popular in practice placements in healthcare higher education. Mobile devices facilitate access to information and allow students to combine theoretical training and clinical skills when they are used in clinical placements, among other benefits.

1. Introduction

Clinical placement is an essential part of healthcare students education which educational institutions spend significant resources to organize. The learning process in clinical placements involves several actors such as tutors, supervisors, teachers and students and during this complex process, tasks and mentorships must be done in a way that is synchronized with educational and clinical processes and embedded in the respective contexts.

Contemporary health systems are aimed at more integrated and person-centered care models and the use of technology is becoming the rule rather than the exception in most of the processes related to the provision of care. In this context, healthcare Higher Education Institutions (HEIs) are introducing the use of technology in their degree programs intending to train their students in basic skills in digital health and prepare them for their future workplaces. Mobile technologies, together with respective digital literacy should allow professionals to face the complex challenges of current health systems and students to facilitate their learning during periods of clinical practice. Especially in practice-based learning scenarios, this can help to achieve competencies through identifying learning needs, the context where the practices are carried out, their purpose or the objectives to be achieved, the way of assessing the students, the practice education model and the involved actors.

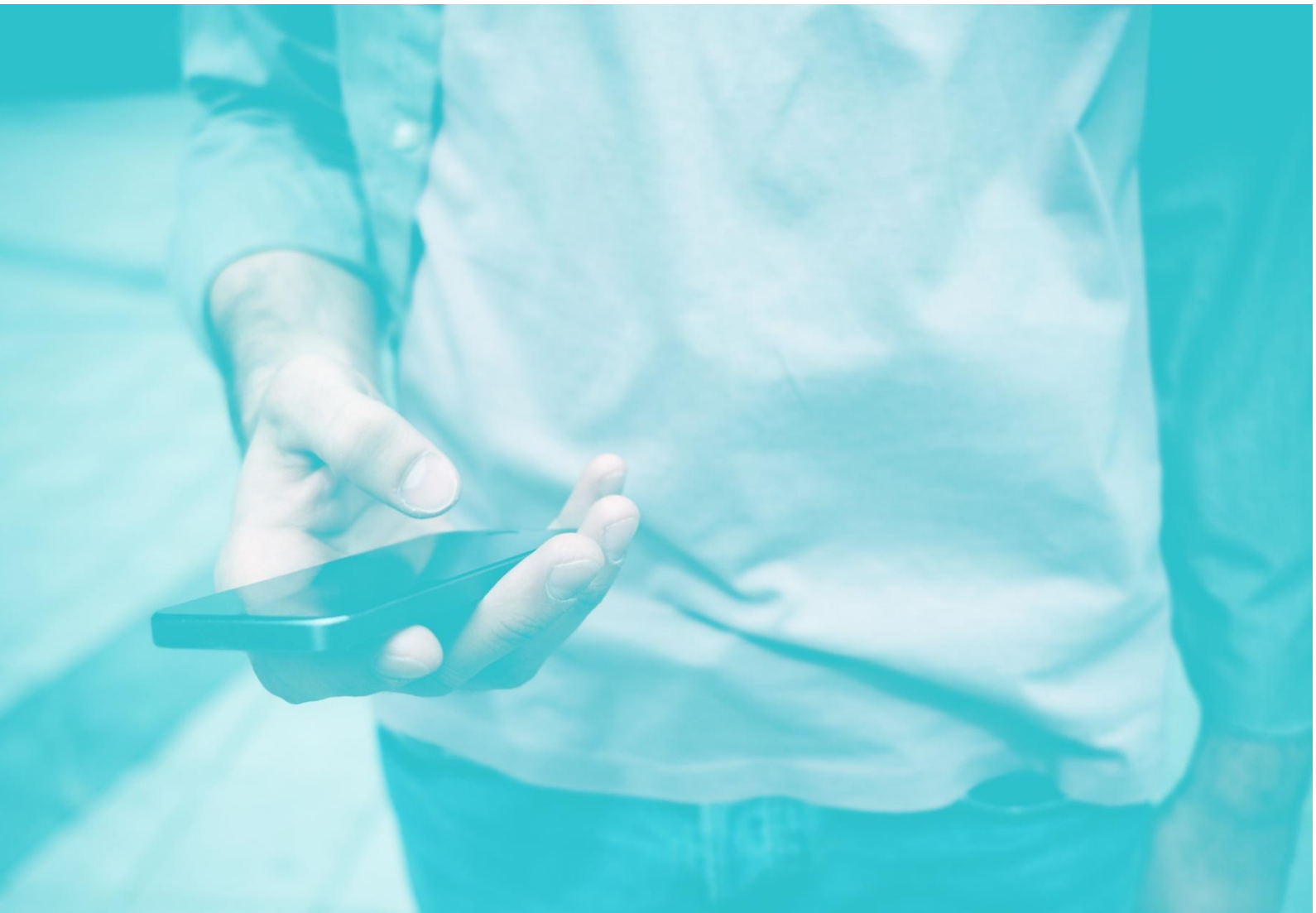
The 4D project (Determinants, Design, Digitalization, Dissemination) in the Digitalization of Learning in Practice Placement, funded by the European Commission, has investigated how to introduce mobile technology in practice placements, creating a bridge between the different actors involved learning contexts to foster the best experience in practice-based learning in healthcare settings.

In this first part of the report, we describe the key factors of the different models and theories in practice-based learning (centers, different actors, processes) and the main elements that need to be considered in the process of introducing mobile technology into practical education in a clinical environment. Specifically, identifying and analyzing the main facilitators and barriers. In the second part of this report through a qualitative approach, we explore and discuss the needs and perspectives of health care students and stakeholders involved in clinical education. We developed this briefing with the results from a collaborative literature review and focus groups interviews with students and other stakeholders involved in clinical education. The main findings are reported in the following sections.

Both reports, *'Report #1 on Key Factors for the Success of Digitalization of Practice-Based Learning in Higher Health Education'* and *'Report #2 on Recommendations to Ensure the Introduction of Mobile Technology in Practice Environments,'* have been developed based on the results of a literature review and a series of focus groups conducted with students and other stakeholders engaged in clinical education in three different contexts (Poland, Spain, and Germany). The main conclusions are presented in the following sections.

Results from evidence Report 1

Key factors, perspectives and needs of actors involved to digitalize successfully practice-based learning in healthcare higher education.



2. Results from evidence of the literature review and main findings

2.1. Literature review

In this first part of the report, we describe the key factors of the different models and theories in practice-based learning (centers, different actors, processes) and the main elements that need to be considered in the process of introducing mobile technology into practical education in a clinical environment. Specifically, identifying and analyzing the main facilitators and barriers.

2.1.1. Models and theories in practice-based learning

In the medical professions, clinical training is just as important as theoretical education. Clinical education aims to ingrain professional competence in students based on the acquired theoretical knowledge. In addition, during clinical education, the student also develops his or her personal qualities, which ensure successful functioning after entering the profession (Dobrowolska et al., 2015). A major challenge for universities during clinical education is to prepare a consistent training system and use different methods to improve the quality of education in this field. High-quality clinical education guarantees the strengthening of the healthcare system, higher quality healthcare services, and the advancement of society (Pashmdarfard et al., 2020).

Problem-based learning in the process of training healthcare professionals

Problem Based Learning (PBL) is an important component of medical education. PBL is a method in which focus is placed on student's search for a solution to a real-world problem. This is different from traditional methods which are based on the teacher giving a lecture on a topic and discussing its practical application. This method supports the application of knowledge and flexibility in thinking about diagnosis and ways to solve problems (Lawal et al., 2021). The key to the success of PBL stems from adopting a viewpoint in which students are active participants in their own learning process and are effectively "learning to learn". This gives them an awareness of ownership of this process by strengthening their critical thinking, communication and teamwork skills. At the same time, teachers must accept the transition of roles – from "knowledge providers" to "knowledge broker" (Lawal et al., 2021). In the PBL process, the academic teacher models' students' leadership skills and clinical reasoning and develops students' sense of self-efficacy in problem solving by providing positive feedback on the learning process (Wosinski et al., 2018).

Problem-based learning is a didactic method which promotes clinical reasoning and develops the effectiveness of cognition in solving clinical problems as well as transformative metacognition owing to which students can transfer and apply this skill in situations encountered in daily work (Wosinski et al., 2018). Problem-based learning enables the

development of these skills by way of solving a clinical problem and critically analyzing, for example, different interventions and their impact on patient management (Lawal et al., 2021).

The problem-based learning method is associated with practice-based education. Practical classes are crucial in applying the acquired skills in real-world settings such as a hospital environment (Nyoni et al., 2021). Today, the expectation is to adopt active education models focused on student engagement and shifting much of the responsibility for learning outcomes to the student rather than to the mentor or teacher (Mackintosh-Franklin, 2016). The following are important in practice-based education: lessons learned, interactions with ward staff, peers and patients, and information processing (Stoffels et al., 2021).

An important element in PBL is reliance on research-based education in which educators teach and students are taught, through inquiry and scientific research. The term research-based education is related to the term "evidence-based practice" (EBP), denoting the use of the best evidence from high-quality research, backed by the clinician's expertise and the patient's preferences and values with respect to the provision of care. Research-based education is a concept focused on organizing an educational environment that supports the ability to transfer EBP learning into curricula, including clinical hands-on learning (Helgøy et al., 2022).

Work-integrated learning

In the healthcare professions, an important aspect of training stems from combining theory with practice and from implementing theoretical knowledge in real work situations across various situations and contexts. Work-integrated learning (WIL) can help students integrate theory with practice, develop skills and knowledge in practice, and prepare them for professional work. WIL can also foster the exchange of professional experience between different healthcare professions (Karlsson et al., 2022).

Research suggests that in order to facilitate the transformation of theoretical knowledge into practical skills and vice versa, educators should pay attention to certain factors that facilitate this process. These include access to teacher support to make it possible for students to develop their professional identity, the use and combination of different teaching methods, effective cooperation between academic teachers and clinical supervisors (Berndtsson et al., 2020). An important role in work-integrated learning is played by "in-context learning". With an extensive body of clinical experiences, opportunities for active questioning, and feedback received with regard to practice, the planning and implementation of patient care allow for the integration of students' theoretical knowledge with clinical practice (Benner et al., 2010). It is also necessary to minimize the discrepancy between theoretical and clinical training of medical students and aim for measures with which these educational paths will complement each other.

Self-directed learning

Self-directed learning (SDL) is a process in which the student takes the initiative to diagnose his or her own learning needs. The process formulates educational goals, identifies human and material resources to assist in learning, applies appropriate learning methods, and evaluates their effects (Anshu et al., 2022).

Academic teachers play a crucial role in self-directed learning. In this educational process, however, the teacher should be treated as one of the sources of skills, not a source of content. An academic teacher adopts a supportive attitude, assisting students in identifying their learning needs and guiding them skillfully to inspire their creativity and critical thinking. By assuming the role of a partner (which means that the teacher-student relationship becomes more equal, and the student is comfortable about approaching the teacher with questions) and a role model, the teacher is also a source of boost for student motivation (Shrivastava & Shrivastava, 2022).

SDL encompasses many elements of learning, including self-monitoring, interpersonal communication, motivation, planning and implementation, among others. Self-directed learning is an approach that allows people to remain flexible, open to change, agile, and resourceful and develop resilience, e.g., in a constantly changing healthcare organization (Visiers-Jiménez et al., 2022).

The success of Self-directed learning depends on students' involvement in the process – this must begin with acknowledging this method, accepting that SDL can serve as an entryway into medical education, and enabling evidence-based practice (EBP)(Shrivastava & Shrivastava, 2022).

Self-directed learning has been found to support nurses' professional development by opening the possibility of broadening their theoretical foundations and improving the quality of clinical nursing (Visiers-Jiménez et al., 2022). It has also been recognised as an effective and important strategy for accelerating learning among medical students (Shrivastava & Shrivastava, 2022). Consequently, being an independent learner as a student is important, not only in terms of academic performance, but also with respect to continued professional education necessary to stay up-to-date and provide safe care to patients (Visiers-Jiménez et al., 2022).

Review of selected educational methods used in practical teaching

With such rapid scientific and technological progress in modern society, the search for new solutions in the field of education can be considered highly important. Compared to their predecessors, younger generations of students have different preferences and expectations as learners. There is a growing demand among today's students for new, adaptive learning methods. Members of this generation (Gen Z) use the Internet and social media on a daily basis and this has become part of their daily life and social interactions. In this regard, it is vital for educational methods to be adapted to the current needs of students (Szymkowiak et al., 2021).

Mentoring is an increasingly common model used in education because it provides customized and holistic support for students' learning process. It entails a relationship, either formal or informal, between a novice and a person who has experience in a particular field. It is increasingly gaining recognition as a two-way process that benefits both mentors and mentees. An effective mentor-mentee relationship is key to successful mentoring and requires preparation, dedication, and time from both parties (Bettin, 2021; Burgess et al., 2018; Hee et al., 2019; Henry-Noel et al., 2019).

Mentoring constitutes an essential process in academic medicine and is considered crucial for a successful and rewarding career in the medical field. Therefore, introducing mentoring into a student's life can help a student early on in that path (Ramidha, 2019).

When performed properly, mentoring provides individualized, impactful and timely support. It allows for the professional and personal development of the student and medical professionals, and shapes their values and beliefs, as well as their professional identity and professionalism (Bettin, 2021; Hee et al., 2019). Furthermore, it allows the curriculum knowledge to be expanded to include content, not covered in textbooks, on professionalism, ethics, values, and the medical art. The evident result is increased academic productivity and satisfaction among students. At the same time, students can build a contact network in their field of interest. The benefits for mentors identified by the authors include professional activity, rejuvenation, and supporting the professional development of the next generation (Henry-Noel et al., 2019).

In healthcare training, mentoring can be provided at hospitals, universities, and training organizations. The practice of mentoring can facilitate understanding the durable components of practice in these organizations. Mentoring includes both a coaching role and an educational role (Burgess et al., 2018).

It should be characterized by self-awareness, focus, and mutual respect. It should be based on the principles of proper communication (Henry-Noel et al., 2019).

Mentors are role models for safe and effective practice. They support learning in line with the scope of practice to aid the students in achieving the required skills. The mentor provides assistance and supervision, in addition to feedback on the student's progress. He or she has up-to-date knowledge and experience in the area where support, supervision and feedback is to be provided (Nursing and Midwifery Council, 2018).

An effective mentor has qualities such as enthusiasm, generosity, patience, sense of humor, knowledge, and competence. The ideal mentor will have the readiness to share personal and professional experiences; selflessness; the ability to transfer knowledge, skills and values; and the ability and willingness to promote networking opportunities for the student. The mentor is an advocate for the mentee (Burgess et al., 2018; Henry-Noel et al., 2019).

The "flipped classroom" model assumes that students become familiar with the theoretical material at home (through knowledge and understanding), so they come to class prepared and carry out practical tasks and exercises to consolidate and check what they learned (application, analysis and synthesis) (Ramnanan & Pound, 2017). The teacher is present during the class and has the opportunity to supervise students' activities, check if students are making progress with the material, and can also introduce more active forms of work - in pairs and groups or through discussions, quizzes and projects (Blair et al., 2020; Ramnanan & Pound, 2017). Rather than just a lecturer, the educator becomes more of a guide, facilitator, and mentor for students. Students can therefore take responsibility for acquiring knowledge, are able to learn independently and apply theory in practice; they can also self-assess and evaluate each other (E. Chan et al., 2021). The problem of failing to understand the material is reduced to a minimum, and students who are prepared for the lessons gain the confidence necessary for active participation in class.

A typical "flipped classroom" model consists of three permanent elements: student's preparation with the help of materials provided by the teacher, face-to-face activities, and post-class assignments (Im& Jang, 2019; M. K. Lee & Park, 2018; Oh et al., 2017; Park & Park, 2018). This method requires a substantial degree of involvement from both parties: the student and the teacher. The materials are usually distributed among students via an internal online system, at least seven days before classroom lessons. In the current age of technological advancement, forms of education that can be used include video recordings of lectures; narrated multimedia presentations; or instruction videos on how to carry out a particular

nursing procedure, supplemented with reading materials (Greenwood & Mosca, 2017; Oh et al., 2017; Park & Park, 2018).

A review of the literature shows that medical students are satisfied with the change from conventional learning to a "flipped classroom". Studies published to date reveal high student satisfaction with the use of pre-lesson educational resources prepared in a manner which is based on a proven theory of learning and makes efficient use of modern technologies (Kim et al., 2017; Ramnanan & Pound, 2017; Saunders et al., 2017). Perhaps this is because this method allows students to get actively involved in the learning process from the very beginning, rather than being passive listeners. Furthermore, "flipped classroom" strengthens students' bonds within a team when they work in groups of several people (Xu et al., 2019).

Narrative medicine in the education of medical students focuses on its objectives of instilling in students the ability to listen carefully to the patient and to reflect with a view to facilitating a holistic approach to care for the patient and his or her family. One of the ways to develop reflective skills is through reflection groups, in which patient cases are discussed in an atmosphere of mutual respect, with focus placed on understanding the problem rather than immediately providing a solution by sharing instructions on how to proceed. Another method for improving reflective skills is creative writing, as part of which participants share ideas, inspire each other, and broaden their imagination. An important element of narrative medicine is building relations with their recipient, for example the patient (Huang et al., 2019). Narrative medicine encourages members of healthcare personnel to use their creativity as a tool for professional development (Lijoi& Tovar, 2020). The use of narrative medicine in the education of medical students benefits their professional development by teaching them to approach patients in an understanding, compassionate and empathetic manner (Milota et al., 2019), as well as it improves their listening and observational skills and the ability to reflect and assume another person's perspective (Marchalik, 2017). Other important elements that are specific for narrative medicine and should be passed on to students during professional training are as follows: taking an interest in the patient; observing the patient's non-verbal behaviours; refraining from judging or interrupting the patient; waiting for the patient to break the conversational silence first; listening to the patient's cues and following them; bearing in mind the context of the disease as well as the feelings of shame, fear and guilt that accompany patients, and their beliefs as to the cause of the disease(Zaharias et al., 2018).

An element that can support clinical reasoning and boost the decision-making and diagnostic process is mind mapping. This method uses a combination of text and graphics to make abstract problems more concrete and simplify complex issues. The use of mind maps in teaching can to some extent help students in problem-based education by breaking down complex problems. This, in turn, can improve students' learning outcomes. The authors' research indicates that the combination of PBL and mind mapping promotes the mastering of theoretical knowledge, improves practical skills, and increases satisfaction with self-learning (Gao et al., 2022).

Interprofessional education

Increasing attention is being paid to interprofessional education, defined as a process in which two or more professions learn together, from and about each other, to improve collaboration and quality of care (Visser et al., 2017). During such classes, both teachers and students from two or more health professions work together to create a collaborative learning environment (World Health Organization, 2010). The primary methods of interprofessional education are

based on small-group activities, collaborative discussions around specific cases, role-playing, and, increasingly, scenarios enacted in medical simulation (West et al., 2016).

As part of interprofessional education, students should learn and understand each other's responsibilities and professional roles, learn how to communicate and resolve conflicts together, and gain a basic knowledge of ethical practice (Van Diggele et al., 2020). Teachers should also remember about engaging students in reflective interaction with each other, as well as mutual teamwork and leadership formation in care teams. Programs that cover interprofessional education require the participation of an educator who understands how healthcare professionals work together in patient care. Teamwork in the medical professions is extremely important and should be trained as early as the university stage. This allows for more effective communication and cooperation among medical professionals, which in turn contributes to improved patient satisfaction, reduced medical costs, lower incidence of medical errors, increased patient safety, and better quality of medical care (Jung et al., 2020).

Organization and structure of clinical education

Practical education involves a three-way partnership between higher education institutions, students, and the clinical community (Stoffels et al., 2021). The role each of these parties plays in clinical teaching is interdependent and critical to the development of competences among nurses in training (Munangatire & McInerney, 2022). Collaboration between academic teachers and clinical supervisors is aimed at integrating theoretical and practical knowledge, including developing the ability to apply knowledge in practice and preparing for professional work (Berndtsson et al., 2020). The structure of clinical training for medical students varies from country to country, and the organization of clinical training is based on standards set at the national or local level. The university will usually sign a contract with a hospital or another medical facility, in which obligations are specified for both parties (Dobrowolska et al., 2015; Nordquist et al., 2019).

There are many terms (clinical teacher, lecturer practitioner, practice educator, link lecturer, clinical facilitator, link teacher, link tutor) to describe the role of a nurse employed in an academic setting, who is responsible for supervising the development of students' clinical skills and linking theoretical knowledge during clinical practice (Pedregosa et al., 2020). Irrespective of the nomenclature adopted, it is very common for a nurse to take on at least three roles: the academic role related mainly to the university, as a clinical educator in practice, or as a teacher in both clinical practice and the university. If the nurse works only at the university, she is supplemented by clinical internship coordinators, clinical supervisors, and clinical instructors. Clinical instructors are employed by an academic institution to provide clinical teaching. In addition to nurse educators and clinical instructors, there are also nurses employed in hospitals, where they are responsible for organizing nursing care and perform a teaching role (Munangatire & McInerney, 2022). A clinical instructor assumes direct supervision of a group of 6-8 nursing students in a clinical unit (Rodger & Juckes, 2021).

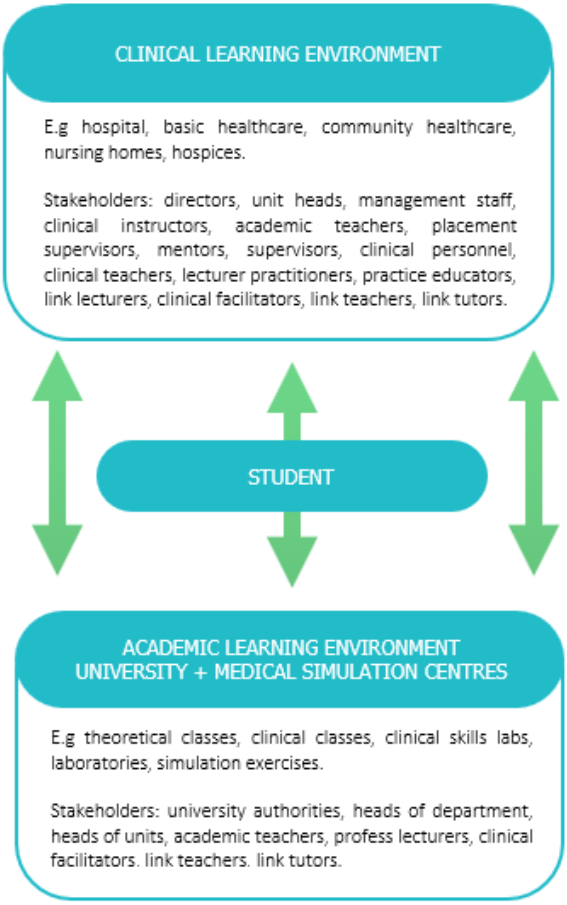
The key role in clinical training is played by a clinical mentor who directs and supervises students' practical training. To a large extent, it is up to clinical mentors to determine to what extent students achieve the desired learning outcomes in terms of practical skills. Their responsibility is to facilitate the student's integration into the clinical environment and is responsible for assessing the competencies acquired by the student during clinical training. We can distinguish between two types of clinical mentors. A teacher can be a person employed at

the university who enters the clinical environment from another field. This type of mentor can spend more time with students and focus on their individual problems concerning the skills they are acquiring. He or she will usually be familiar with curricula, as well as the learning outcomes and teaching methods. A teacher can also be a person employed at a medical facility, thus being able to introduce students to the realities of work in a clinical setting and integrate them into the team. This, however, often comes at the cost of reduced availability of the mentor for the students. Such mentors sometimes experience role conflicts which result from meeting patient care requirements while performing clinical mentoring duties for students (Carnwell et al., 2007; Dobrowolska et al., 2016).

In clinical education, we can also encounter link tutors who are university employees responsible for and overseeing the implementation of the curriculum during clinical classes; they also provide students with learning support and monitor their performance. Link tutors are also in charge of quality assurance and the auditing of practical classes, and their role focuses on problems that arise in the course of clinical training. When working with clinical mentors, link tutors have the task of preparing them for their role and supporting them in their practice and its implementation, which is evidence- and curriculum-based. Link tutors should inform mentors about educational changes and program modifications, report on student learning outcomes, and provide support in the student assessment process (Carnwell et al., 2007).

In Europe, student supervision during part of clinical classes is ensured by academic teachers; during the other part, it is supervised by employees of the facility where the classes are held (Dobrowolska et al., 2016). Alternatively, a member of the staff may also be employed on a part-time basis as academic teacher or, vice versa, an academic lecturer is an employee of a healthcare facility (Dobrowolska et al., 2016; Saarikoski et al., 2013). With such a mentoring model, the teacher remains in contact with the student during both theoretical (at the university) and practical classes.

Figure 1. Stakeholders involved in the process of practical training



The roles of clinical educators/instructors vary from country to country mainly with respect to their responsibilities and employment status. For example, academic stakeholders are concerned that the biggest challenge for clinical educators is their inadequate preparation, which leads to poor educational outcomes (Jetha et al., 2016). Nursing instructors should be required to have an academic background, and in order to improve the quality of clinical education, curricula should be systematically developed for nurses who want to work as clinical instructors (Beiranvand et al., 2021).

To illustrate the various approaches to actors in clinical education, we have provided some examples. In Austria, the system of mentoring during clinical practice is divided between nurse educators and ward nurses. The teacher accompanies the students for at least 50 hours during the three-year training. They receive instruction in nursing care planning, clinical skills, and communication with patients. They are also given feedback from their teacher on their performance. For the remainder of the clinical practice, nursing students are supervised by a ward nurse. Clinical internship promotes cognitive, affective and psychomotor skills and is firmly committed to facilitating the development of professional competence and identity (Mueller et al., 2018). In the UK, on the other hand, mentoring in nursing is an integral part of undergraduate education and applies to every nursing student. Throughout their clinical internship, students are supported and evaluated by their mentors. During the placement, known as a clinical internship, students receive support from the clinic and the university, including medical staff, mentors, internship educators, practitioner-teachers, clinical supervisors, and link lecturers (Foster et al., 2015). Job opportunities for clinical education nurses are available in Finland – nurses are mainly employed by hospital organizations, being responsible for organising clinical placements in cooperation with clinical educators. In Sweden, by contrast, clinical educators are employed by universities and serve as a link between university and clinical placements. In some countries, such as Australia, universities and healthcare units jointly run clinical education departments or dedicated educational units to provide clinical placements for nursing students (Kaarlela et al., 2021).

The clinical learning environment includes various elements that can be favourable in terms of students' preparation for practice. These include physical space, organisational philosophy, the characteristics of clinical instructors, learning opportunities offered, and relationships with educational and service personnel (Flott& Linden, 2016). One of the key challenges in shaping a clinical learning environment results from the excessive workload of clinical staff (Pedregosa et al., 2020). The provision of amenities to facilitate learning and access to physical settings conducive to clinical learning is fundamental for the development of clinical skills (Gosak et al., 2021).

As can be noted, the clinical learning environment is multidimensional. It comprises many correlated and intertwined factors: human resources, interpersonal relations, work organization, and structuring of the learning process. It is therefore important to assess and monitor both the organizational and learning climates and the correlation between them. Consequently, more and more tools are being developed to assess the medical educational environment. The Dundee Ready Educational Environment Measure (DREEM) is a widely accepted and globally validated tool for collecting information on the medical educational environment at the undergraduate level (Prashanth & Ismail, 2018). The educational environment in which students stay has a significant impact on their behaviour, academic achievements, aspirations, and satisfaction with their studies. Competitive, authoritarian, stressful or threatening environments can undermine interest and engagement during the learning process. Assessing students' perceptions of the educational environment is important to improve the quality of educational programmes (Shrestha et al., 2019). DREEM is used by

many institutions for diagnosing the institutional status of the educational environment and to make comparisons between different programs. The questionnaire makes it possible for educational administrators to identify problem areas at the program or institutional level, as well as being helpful in making necessary changes, which results in significant improvements in the learning environment (Prashanth & Ismail, 2018). Another example of a tool is the Clinical Learning Environment and Supervision plus Nurse Teacher (CLES+T) scale. The CLES+T scale is used to assess students' experience in the clinical learning environment of a hospital unit. The dimensions assessed by CLES+T are the pedagogical atmosphere (nine items), the leadership style of the unit manager (four items), the nursing rooms on the unit (four items), the supervisor relationship (eight items), and the nurse-educator scale (nine items) (Tomietto et al., 2016).

A common aspect for all countries providing clinical education is the cooperation between the academic organization and the medical organizations where clinical classes are conducted. Collaboration between both clinicians and university staff has several potential benefits such as identification of clinical problems, more opportunities to practice clinical skills, and significantly improved patient communication and positive teamwork (Direko & Davhana-Maselesele, 2017; Pedregosa et al., 2020). Good cooperation between all actors involved in practice education ensures an optimal clinical learning environment, and this is a key factor in achieving the intended learning outcomes. This can be achieved through the proper flow of information between facilities, forming strategic collaborations and building collegiality among researchers, clinicians and students (Antohe et al., 2016; Jayasekara et al., 2018).

2.1.2. Digitalization trends in practical education of future health care/medical professionals.

In the medical professions, clinical training is just as important as theoretical education. Clinical education aims to ingrain professional competence in students based on the acquired theoretical knowledge. In addition, during clinical education, the student also develops his or her personal qualities, which ensure successful functioning after entering the profession (Dobrowolska et al., 2015). A major challenge for universities during clinical education is to prepare a consistent training system and use different methods to improve the quality of education in this field. High-quality clinical education guarantees the strengthening of the healthcare system, higher quality healthcare services, and the advancement of society (Pashmdarfard et al., 2020).

Introduction

The last decade saw various calls for innovation in undergraduate health professions education (World Health Organization, 2010), so learning methods and pedagogy are shifting in clinical education (Moro et al., 2020). Particularly, digital education and the use of information and communication technologies (ICT) have increasingly been used in health professional learning (Car et al., 2022; Fontaine et al., 2019). In this sense, universities are using progressively more ICT technologies based on smart and connected information systems, such as electronic medical

records. This allows students to access computerized records of patient health data and acquire skills in collecting, recording and managing health data (Raghunathan et al., 2021).

E-learning is defined as the use of ICT to support learning (Clark & Mayer, 2016). E-learning is increasingly present in clinical and academic settings for the education of health profession students, creating environments that appear to be effective in improving skills in health professionals' students (Fontaine et al., 2019). Moreover, health profession students show a positive response to e-learning regarding perceptions, acceptance, motivation, and engagement (Naciri et al., 2021). Modalities to provide synchronous, active learning drills with participants in different locations have been defined as tele-, remote, distance, virtual, mental and online simulation (Lioce et al., 2020).

Global technological progress and the development of smart technologies have also made it possible to introduce modern solutions into the practical training of health profession candidates (Ghasemi et al., 2020). The increase in the use of digital technology in higher education is closely linked to the global integration of digital technology in everyday life (Olivier et al., 2020). In a digital world, learners are different and have grown up with and are hyper-connected through the Internet (Boysen et al., 2016; Friedman et al., 2016). New student's generations prefer learning through innovative methods such as audiovisual simulations and observations (Kinder & Kurz, 2018).

This process has also been accelerated by the SARS-CoV-2 pandemic, during which traditional teaching in classrooms and healthcare facilities had given way to remote instruction, also in medical simulation centers. Finding effective solutions for remote teaching in medical university programs that rely on hands-on education was a challenge for educators (Naciri et al., 2021). During the COVID-19 pandemic, various types of platforms were developed to allow both asynchronous and synchronous learning. Asynchronous systems do not require real-time interaction between parties of the educational process – they are based on a "request-response" system; examples include Moodle or Blackboard platforms. Synchronous platforms, such as Zoom, Skype or Microsoft Teams, allow the exchange of information in real time (Turnbull et al., 2021). Teaching with short videos available for watching on mobile devices and the use of mobile apps are becoming increasingly popular (Hester et al., 2021). In addition, the development in technology, applications and online platforms (Facebook®, WhatsApp®, etc.) allows for faster exchange of educational materials and communication between students and teachers (Coleman & O'Connor, 2019). In the studies, their authors point out that technology allows students to access many websites and applications that enable them to make reasonable clinical decisions in class and make their ideas more innovative (Gause et al., 2022).

Clinical education programs need to promote student's self-directed learning, stimulate their motivation, guide them in setting learning goals and implement effective learning strategies (Wang et al., 2019). It is necessary to use new practices to increase education's permanence and ensure that students take on their roles (Bilgiç et al., 2021). Learners are at the core of digital health education, so their preferences, needs, experiences and competencies are considered when education is delivered (Car et al., 2022).

Digital trends

Digital health professions education refers to teaching using digital technology (Car et al., 2019). There are different digital education technologies modalities, as are defined below:

1. Offline digital education: it does not require an internet connection and can be delivered through external media, including CD-ROM, USB stick, etc. (Hervatis et al., 2018).
2. Online digital education is designed to be delivered on PCs, requires an internet connection and includes multiple media formats (online discussion, chat, videoconferencing, videos, etc.) (Paul et al., 2018).
3. Virtual reality: involves interactive exploration of a digital (3D) multimedia environment which can reflect a real-world environment (Kyaw et al., 2019; Moro et al., 2020; Saxena et al., 2016). For example, it can be used to provide 3D representations of the human body when learning physiology or anatomy structures. The users' senses are fully immersed in a synthetic environment that mimics the properties of the real world (Moro et al., 2020).
4. Augmented reality: this technology superimposes a computer-generated image on a user's view of the real world by using a camera and screen. Students can interact with both real and virtual elements (Moro et al., 2020). Allows the opportunity to provide interactive 3D resources outside the classroom (Birt et al., 2017) and create clinical scenarios (Sutherland et al., 2019).
5. Holograms and Mixed reality: this technology is relatively new, and most products are still in the developer level stage. Holograms can incorporate gestures, voice commands and interactions with models, providing a new student-center teaching modality (Moro & Gregory, 2019).
6. Virtual patient: it simulates real-life clinical scenarios where students can act as real health professionals conducting a physical examination or making therapeutic and diagnostic decisions (Quail & Boyle, 2019).
7. Virtual dissection tables: is a new way to learn anatomy instead of cadaveric dissection. It is used in several health profession studies enhancing the ability of learners to explore different anatomical components easily (Narnaware& Neumeier, 2020; Periya& Moro, 2019).
8. High-fidelity manikins: are used to simulate clinical scenarios because they can mimic elements of human physiology (Carey & Rossler, 2022).
9. Massive open online course: free online courses that are available over the internet to a large number of participants (Mahajan et al., 2019).
10. Serious gaming and gamification: learning activities are set within a competitive virtual environment in order to promote the development of knowledge, cognitive and psychomotor skills (Gentry et al., 2018). It promotes knowledge acquisition, motivation, perception and improves learning outcomes (Boyle et al., 2016).
11. Social media: it allows sharing information instantly and teaching skills, enhances collaborative learning and educational practice, engages learners, promotes self-efficacy and supports student-centered learning (O'Connor & Andrews, 2018; Sterling et al., 2017).
12. Mobile education (m-Learning): a flexible and accessible learning delivered via personal devices, like smartphones or tablets (Crompton, 2013). Mobile devices are capable of providing access to a wide variety of educational resources (Moro et al., 2020), enhancing reflective practice and leading to improved learning outcomes (Pimmer et al., 2016). Smartphone m-Learning is an effective tool that improves knowledge, skills, confidence and attitude towards learning (Kim & Park, 2019). Is efficient and beneficial when acquiring new knowledge and skills and it is seen to be an appropriate complement to traditional learning methods (Klímová, 2018).
13. 3D printing: is used in education and clinical training across a number of disciplines, such as physiotherapy or surgery, providing virtual anatomical models and surgical instruments that can be used for educational purposes (Malik et al., 2015). 3D printed anatomical models promote self-directed anatomy learning and provide a readily available source of supplementary teaching materials (Lim et al., 2016). Students feedback is positive and

obtains better results in knowledge acquisition and structural conceptualization when using 3D printed models (Su et al., 2018).

14. Online-Hosted video: is a cheap and accessible way as video content can be easily uploaded to learning management sites or online repositories (Moro et al., 2020).
15. Simulations with Technology Enhanced Learning: simulations provide a safe environment to practice skills before performing procedures in real life (Martin et al., 2020). Modern simulations are increasingly using technology-enhanced learning to create virtual patients, scenarios or environments (Moro et al., 2020). Simulation has become an important learning method in contemporary health professions education (Gough & Nestel, 2018).
16. Audience response: allow students to participate actively in the class by selecting answers to questions in real-time displayed in different programs and controlled by educators (Moro et al., 2020).

Advantages of digital education

Digital trends have been incorporated in clinical education of all health sciences professions. These innovative methods have been applied in a range of learning and teaching contexts, including feedback and assessment, clinical skills and techniques, professional behaviours, clinical reasoning, and fieldwork supervision (Olivier et al., 2020). These digital trends offers many advantages, as shown below:

1. Flexibility: In general terms, the use of digital technology in health professions education provides more accessible, standardized, relevant, timely and affordable education and training. Digital education provides flexibility in terms of learning anytime, anywhere. Students can access the course materials at their convenience and learn at their own pace (Hippe et al., 2020; Tumlinson et al., 2019).
2. Cost-effective: Digital education is often more cost-effective than traditional classroom-based learning as it eliminates the need for physical infrastructure and other associated costs. For example, personalized augmented reality systems promote autonomous learning and reduce laboratory materials and educators' expenses (Uruthiralingam& Rea, 2020).
3. Improved accessibility: Digital education is accessible to anyone with an internet connection, which means students from remote or rural areas can also access quality education. These remote tools can be used to effectively reach trainees in rural or more resource limited settings to connect to other learners, faculty or even other curricula (Sanseau et al., 2021). Advanced technology enhances students' learning by providing learning opportunities whenever they are needed and with whatever resources they can access despite geographic distance (Han et al., 2019).
4. Personalized learning and self-directed learning: Digital education platforms often use adaptive learning technology to personalize the learning experience for each student. Ho et al., (2021), demonstrated that a teaching intervention program based in an iLearning app improved the clinical reasoning and self-directed learning in nursing students.
5. Increased interactivity: Digital education often incorporates multimedia elements like videos, interactive quizzes, and simulations, which can make the learning experience more engaging and interactive. For example, virtual patient and augmented reality simulations can offer realistic medical conditions without risk of patient harm and facilitate students' learning and engagement (Uruthiralingam& Rea, 2020).
6. Increased student confidence: In addition, practical training is increasingly being provided in simulation centers, where modern equipment uses simulation aids to recreate clinical

scenarios. Simulation tools are an alternative to the 'real-life' patient – here, the student can make mistakes and learn from these tools without concerns about causing any damage to the patient (Bruce et al., 2019). Simulation methods also allow the mastering, through repetition, of manual skills. Simulators are particularly useful for training procedures and techniques that cannot otherwise be performed in practice or are rarely encountered in work settings. Simulation improves students' competence and performance, as well as their satisfaction and the opportunity to practice in real situations (World Health Organization, 2013).

7. Improving student skills and learning outcomes: Digital technologies also enhance students' knowledge, skills and/or competencies, improving students' learning outcomes (Männistö et al., 2020). For example, virtual reality allows students to improve their skills (Baniasadi et al., 2020). Simulation classes also use virtual reality tools, offering a computer-generated simulation of the real or imagined world. The experience of virtual reality involves immersing oneself in a virtual world and interacting with that environment. VR technology relies primarily on visual interaction with the user, but with the support of various sensors, it provides a fairly realistic feel of the simulated environment. This method is especially popular in the practical training of surgeons, where the student repeatedly practices the surgical process, improving his or her surgical skills in a virtual environment on a virtual patient. This later translates into the quality of the procedure in the operating room (Baniasadi et al., 2020).
8. Better student engagement: Digital education can increase student engagement and motivation. Sanseau et al., (2021), developed a telesimulation education platform, becoming feasible and effective in teaching specific learning objectives and was positively recommended by students and faculty users. Other studies have shown the effectiveness of integrating games into learning apps to facilitate learning complex concepts, enhance learning enjoyment and stimulate learning motivation (Wang et al., 2019).
9. Collaboration: Digital education platforms often provide opportunities for collaborative learning through online discussions, group projects, and peer-to-peer reviews, which can help students develop teamwork and communication skills. For example, game-based methods, serious gaming or gamification are designed to serve not only entertainment, but primarily educational purposes. Games actively engage students in the learning process. Students not only have the opportunity to solve clinical problems and make clinical decisions but also gain experience in a risk-free environment. Furthermore, they enhance their analytical skills, strategic thinking, and multitasking. In some games, several players can participate in the game play, so that students engage in collaborative learning (Gentry et al., 2019).

Incorporating technology in education is important for training health professionals, where the necessary knowledge acquisition is much more experiential and hands-on than in many other disciplines (Moro et al., 2020). Although digital technologies in health profession education are extensive, they also entail challenges that educators and students must deal with to provide effective learning environments (Meum et al., 2021).

Mobile learning

In the 1980s, certain novel methods, including video support, started to be used to teach clinical skills in health sciences (Paul et al., 1998). After, many other digital technologies have been developed and used in health profession education. But, with the development of 3G mobile

technology, which supported high data transfer speeds, efforts to use mobile interventions in education methods started in these past years (Mather et al., 2017).

A remarkable trend within digital education is mobile learning (mLearning), which is defined as a flexible and accessible learning delivered via personal mobile devices, such as smartphones and tablets (Crompton, 2013). Mobile learning (mLearning) is a new stage in the development of e-learning (Nikpeyma et al., 2021)

Mobile devices are considered to be improving the quality of health science education, which is why it has gained popularity as a tool complementary learning opportunity. They reduce the workload of the education system face-to-face service 24 hours a day, facilitate study and reduce education costs (Quant et al., 2016). In addition, mobile technologies increase permanency in education by providing the student with access whenever and wherever he/she wants and repeated watching opportunities (Sung et al., 2016).

Health sciences academics have increased interest in incorporating mobile technology in the classroom as a means to improve the motivation and participation of students (Doyle et al., 2014). A 2015 survey of 500 medical students found that more than 60% of the respondents used their mobile devices for education and more than 75% indicated their interest in learning more about applications available for educational purposes (Green et al., 2015).

The use of digital technology in health professions provides more accessible, standardized, relevant, timely, and affordable medical education and training (Hippe et al., 2020). Wearable smart devices can be adapted to enhance student learning (Sumpter et al., 2022) since they support students particularly in assessment, communication, clinical decision-making, notetaking and accessing information (Maudsley et al., 2019). Moreover, students received this mobile support in learning clinical-practical skills positively (Herbstreit et al., 2021).

Mobile devices are also widely used as a learning tool by medical students in clinical settings (Lee et al., 2021). Over 80% of the knowledge of students is acquired “on the job”, so clinical practice has become one of the most important parts of students' learning (Dornan et al., 2019). Mobile devices facilitate access to information and allow students to combine theoretical training and clinical skills when they are used in clinical placements (Nikpeyma et al., 2021).

However, many challenges regarding implementation of mLearning in clinical contexts have been reported (Lall et al., 2019), despite the support of educators about the use of mLearning in clinical practice as a way to enhance teaching and learning (Willemse & Bozalek, 2015). Some of the barriers described are insufficient institutional structures and resources, a lack of device-focused training and support, and limited planning and leadership of mLearning programs (Lall et al., 2019). In addition, there is a lack of a culture of accepting the use of mobile devices for scientific purposes, especially among staff and patients (Nikpeyma et al., 2021). One of the chief complaints is that students are using their mobile devices and getting distracted (Rashid-Doubell et al., 2016). However, according to studies, the most common use of mobile devices by students is to access information rapidly while in the clinical setting (Chase et al., 2018). Other advantages of the use of mobile devices in the clinical setting include the acquisition and retention of new knowledge (Briz-Ponce et al., 2016), and improved communications (Payne et al., 2012). In clinical attachments, the lack of communication with clinical teaching fellows and other stakeholders involved in learning, presents an enormous challenge for students. This leads to little consistency in the delivery of teaching and sometimes sub-optimal clinical experience (Salam et al., 2021). One of the solutions to this problem is the use of “Instant messaging applications” which facilitate learning by providing a virtual platform

where group collaboration, peer communication and multimedia message sharing are allowed (Coleman & O'Connor, 2019).

Educational reform with technology has been suggested by the World Health Organization (World Health Organization, 2011), but nurses, doctors and other health professions should be involved in the research, design, use and evaluation of innovative health technologies (Sumpter et al., 2022). Moreover, it is also important for healthcare leaders to be part of the conversation to mitigate the barriers and provide useful resources for better learning using mobile devices (Lee et al., 2021).

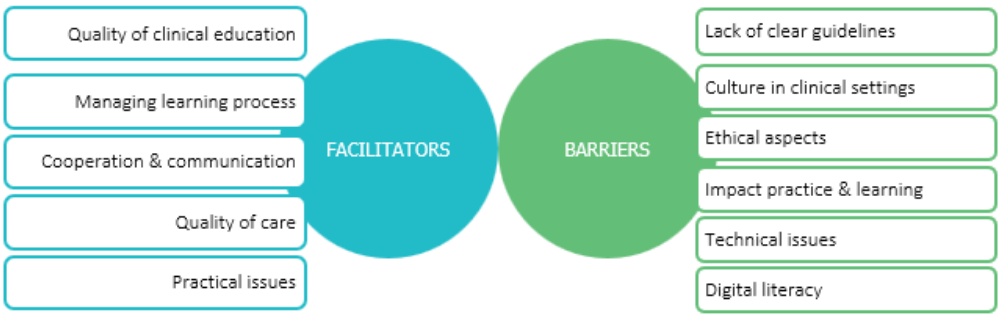
As it has been stated, mobile devices are increasingly used to enable learning, but clinical placements could incorporate them better (Maudsley et al., 2019). The lack of clear policy and training of students and teachers on this aspect might impede the use of mobile devices to maximize learning (Lee et al., 2021).

Due to all advantages that digital trends may have in healthcare higher education but all the challenges that can also entail and because the aim of this report is to determine the key factors to introduce mobile technology in practice placements, the following sections will try to give an overview of the main barriers and facilitators that should be considered.

2.1.3. Key factors to digitalize successfully practice-based learning in healthcare higher education by introducing mobile technology.

Digitalizing practice-based learning in healthcare higher education can bring numerous benefits, including enhanced learning experiences, increased accessibility, and greater efficiency. However, there are several key factors that need to be taken into consideration for successful digitalization. To identify the main elements that need to be considered in the process of introducing mobile technology into practical education in a clinical environment a literature review was conducted. For the search strategy, PubMed, CINAHL, Scopus, Lens, Google Scholar and Web of Science databases were used. Manual searches were also conducted, including reference-sections in core articles and key conference proceedings. Finally, 73 articles published between 2008 and 2022 were accepted for the analysis, identifying some facilitators and barriers which are synthesized in the following sections.

Figure 2. Facilitators and barriers to introducing mobile technology into clinical education.



2.1.3.1. Main facilitators

Introducing mobile technology into clinical education can be a valuable tool for medical and health care students during their practice placements. Here are some main facilitators for introducing mobile technology in clinical education:

Positive attitude of students, educators, staff, and patients towards mobile applications

Generally, there is a positive attitude of students, educators, staff, and patients towards mobile learning in clinical education and find mobile devices useful. They think that using mobile devices in the clinical setting is helpful for students' learning and practice. Students also prefer mobile devices than textbooks and they think they are an entertaining way to learn (Bogossian et al., 2009; Chan & Chan, 2021; Dearnley et al., 2008; Doyle et al., 2016; Farrell & Rose, 2008; Friederichs et al., 2014; George & DeCristofaro, 2016; Gray & Gillgrass, 2020; Johansson et al., 2013; Lamarche et al., 2016; Li et al., 2018; Mann et al., 2015; Mettiäinen, 2015; Nestel et al., 2014; Positos et al., 2020; Rashid-Doubell et al., 2016; Scott et al., 2017; Sedgwick et al., 2016; Strandell-Laine et al., 2019; Willemse et al.,) 2019; Wittmann-Price et al., 2012).

Increasing quality of clinical education

Mobile technology increases the quality of clinical education because it facilitates clinical learning, consolidates learning, support students' target-oriented learning and inspire students' cognitive learning process. Mobile technology also helps students to test their own knowledge and clinical abilities, motivating them to work harder. Additionally, it improves student clinical competency, confidence, and self-efficacy. Facilitate collecting information rapidly integrated in only one source, providing immediate and easy access at any time and from any place to up-to date information (Alegría et al., 2014; Attenborough & Abbott, 2018; Bogossian et al., 2009; Boruff & Storie, 2014; Chan & Chan, 2021; Fournier, 2022; George et al., 2010; Green et al., 2015; Harrison et al., 2019; Ho et al., 2009; Johansson et al., 2013; Koohestani et al., 2018; Lall et al., 2019; Lamarche et al., 2016; Lee et al., 2021; Li et al., 2018; Luanrattana et al., 2010; Mather & Cummings, 2016; Maudsley et al., 2019; Mettiäinen et al., 2015; Nikpeyma et al., 2021; Rashid-Doubell et al., 2016; Strandell-Laine et al., 2018; Willemse et al., 2019; Wu & Lai, 2009; Wyatt et al., 2010).

Managing the learning process

Mobile devices allow tracking of student's progress with intended curriculum outcomes and help them in identifying areas for student improvement. Teachers can also notice which students need more support. Mobile applications also help educators in the dissemination of learning materials, instructions, announcements, assignments and schedules, promoting students' self-organization and helping them to manage their work-life balance (Attenborough & Abbott, 2018; Green et al., 2015; Ho et al., 2009; Lamarche et al., 2016; Luanrattana et al., 2010; Maudsley et al., 2019; Mettiäinen, 2015; Positos et al., 2019; Snodgrass et al., 2016).

Student-student, student- mentor relationship, cooperation and communication

Using smartphones enables better communication and cooperation with peers, teachers, mentors and staff. Being connected to university and peers make students feel more supported and not isolated while they are in clinical placements (Attenborough& Abbott, 2018; Bogossian et al., 2009; Green et al., 2015 ; Ho et al., 2009; Lamarche et al., 2016; Li et al., 2018; Lai & Wu, 2016; Lall et al., 2019; Luanrattana et al., 2010; Mather & Cummings, 2016; Maudsley et al., 2019; Mettiäinen, 2015; Snodgrass et al., 2016; Strandell-Laine et al., 2018, 2019; Willemse et al., 2019).

Quality of care and benefits for patients

Using mobile devices in practice placements has also benefits for patients by reducing the risk of errors, by enhancing evidence-based, safe, and reflective practice and by increasing diagnostic accuracy. Mobile technology also engages patients in their own care and supports

patient education (Chan & Chan, 2021; Fournier, 2022; Mather & Cummings, 2015; Maudsley et al., 2019; Sedgwick et al., 2016; Wittmann-Price et al., 2012).

Practical issues that help

Some practical issues of mobile devices that help and that students appreciate are having all documents in one central and easily accessible place, portability, ease of use, enjoyment and immediacy that mobile devices offer them. Saving on printing and time saving are other of the values of mobile devices have in clinical environments (Alegría et al., 2014; Attenborough & Abbott, 2018; Boruff & Storie, 2014; Friederichs et al., 2014; Harrison et al., 2019; George et al., 2010; Gray & Gillgrass, 2020; Green et al., 2015; Johansson et al., 2013; Lamarche et al., 2016; Lee et al., 2021; Maudsley et al., 2019; Masters & Al-Rawahi, 2012; Mather & Cummings, 2015; Nestel et al., 2014; Nikpeyma et al., 2021a; Pimmer et al., 2018; Strandell-Laine et al., 2019; Willemse et al., 2019).

2.1.3.2. Main barriers

While introducing mobile technology into clinical education in practice placement can offer many benefits, there are also some potential barriers that may need to be addressed. Some of the main barriers to introducing mobile technology into clinical education in practice placement include:

Lack of clear regulations and guidelines for using mobile technology in clinical setting

Using mobile devices in the clinical area as a learning tool is not a formalized process. Some medical school guidelines do not allow its use and healthcare policies are also inconsistent. There is a lack of clear instruction in terms of how to use mobile devices in practice placements and how to integrate mobile devices in student's learning activities (Attenborough & Abbott, 2018; Harrison et al., 2019; Lall et al., 2019; Lamarche et al., 2016; Lee et al., 2021; Mather & Cummings, 2015; Rashid-Doubell et al., 2016; Strandell-Laine et al., 2015).

Culture in clinical settings

There is a lack of a culture of accepting the use of mobile devices for scientific and educational purposes. Teachers, patients and staff do not like students using devices, especially senior staff and ward management. Additionally, students feel rude to use mobile devices in front of patients and report that staff and patients assume they are using the device for personal reasons (Alegría et al., 2014 ; Attenborough & Abbott, 2018; Beauregard et al., 2017 ; Bogossian et al., 2009 ; Chan & Chan, 2021; Fadi et al., 2015; Farrell & Rose, 2008 ; Fournier, 2022; Gray &Gillgrass, 2020; Green et al., 2015 ; Harrison et al., 2019; Johansson et al., 2013; Lamarche et al., 2016; Lee et al., 2021; Lall et al., 2019; Mann et al., 2015; Mudsley et al., 2019; Nikpeyma et al., 2021; Rashid-Doubell et al. 2016; Willemse et al., 2019).

Ethical aspects, privacy, and security

Concerns about confidentiality, privacy and patient security are reported in several studies when students use their private phones. Mobile technology may also have a negative impact on communication with patient, perception of care and compassion (Beauregard et al., 2017; Bogossian et al., 2009; Chan & Chan, 2021; Luanrattana et al., 2010; Mann et al., 2015; Mather & Cummings, 2015; Maudsley et al. 2019; Wittmann-Price et al., 2012; Wyatt et al., 2010).

Negative impact on practice and learning

Mobile technology can become a distraction that impends the learning process and interferes the development of a relationship between students and clinical mentor, which is the most important learning resource. Also inhibits students' learning from patient observation. It can also be a risk for patients and affect face-to-face communication reducing interpersonal

communication and eye contact (Harrison et al., 2019; Luanrattana et al., 2010; Maudsley et al., 2019; Mann et al., 2015; McNally et al., 2017; Mather & Cummings, 2015; Nikpeyma et al., 2021; Rashid-Doubell et al., 2016; Snodgrass et al., 2016).

Technical issues
Issues related with the battery life of the device, the small screen to read all learning materials, a complicated scroll view, problems with the device memory and Internet connection, especially in resource-limited settings, few charging ports available and non-friendly interface. Moreover, some clinical settings do not allow students to use their Internet and wi-fi. Other issues are related to data synchronization or non-transferability to different mobile devices, functionality of software and hardware, and having less features than a computer. Other barriers are the lack of technical support, issues regarding the risk of theft and damage, the risk of contamination of mobile devices and the cost of applications, mobile devices and Internet packages (Attenborough & Abbott, 2018; Boruff & Storie, 2014; Chan & Chan, 2021; Davies et al., 2012; Dearnley et al., 2008; Farrell & Rose, 2008; Fournier, 2022; Friederichs et al.; 2014; Green et al., 2015; Harrison et al., 2019; Kenny et al., 2009; Lall et al., 2019; Luanrattana et al., 2010; Lee et al., 2021; Mann et al., 2015; Masters & Al-Rawahi, 2012; Mather & Cummings, 2016; Maudsley et al., 2019; Nestel et al., 2014; Nikpeyma et al., 2021; O'Connor & Andrews, 2018; Snodgrass et al., 2016; Strandell-Laine et al., 2019; Willemse et al., 2019).
Information literacy, digital competences, and students' and mentors' skills
Uncertainty about the validity of scientific content on the Internet, lack of fluency in English to use scientific content, and lack of access to all information are some challenges that users must face. Also, there is a lack of mentor's and/or student's skills in using the device and lack of a device-focused training and support (Chan & Chan, 2021; Doyle et al., 2016; Farrel et al., 2008; Fournier et al., 2022; George et al., 2010; Green et al., 2015; Lall et al., 2019; Lee et al., 2021; Mann et al., 2015; Nikpeyma et al., 2021; Strandell-Laine et al, 2019).

2.2. Qualitative approach. Needs regarding mobile technology usage in clinical placement

Due to all the challenges that use of mLearning in clinical placements may have and the importance of considering students and stakeholders when designing innovative educational technologies, focus groups (FG) were conducted. The aim was to explore the use of mobile devices as an educational tool from the perspective of undergraduate health profession students and the main stakeholders involved in professional practical education. Having and in-depth exploration of the range of potential barriers and facilitators of introducing mobile devices in practice placements allow insights to be obtained for effective implementation and positive outcomes.

Participants and setting

The study population were undergraduate health profession students and stakeholders of University of Lublin (Poland), University of Duisburg Essen (Germany) and Tecnocampus (Spain). Participants were selected by purposive sampling with maximum variation. Students were enrolled in an undergraduate nursing, medicine, physiotherapy, or midwife program. Stakeholders were also included with the following criteria: being involved in practical training of future nurses, midwifes, physiotherapist, or doctors as clinical mentor, link teacher or practical training coordinator, hospital ward manager or nurse, midwife, and doctor staff.

In each country, two focus groups were held: one student's FG and one stakeholder's FG, conducting six focus groups in total with 25 students and 26 stakeholders. Approval of the Ethical Committee was obtained from the centers involved: University of Lublin (Poland), University of Duisburg Essen (Germany) and Tecnocampus (Spain). The basic characteristics of participants are included in Table 1.

Table 1. Students and stakeholders' main characteristics

	Poland	Spain	Germany
Students	n=10	n=10	n=5
Age (mean value)	21.3	22.8	26
Gender			
Female	10	7	-
Male	---	3	5
Year of the study	2nd year (n=5)	---	---
	3rd year (n=1)	3rd year (n=2)	3rd year (n=1)
	4th year (n=2)	4th year (n=8)	4th year (n=3)
	5th year (n=2)	---	---
	---	---	7th year (n=1)
	---	---	---
Nursing	2	8	---
Midwifery	4	---	---
Physiotherapy	2	2	---
Medical	2	---	5
Stakeholders*	n=6	n=11	n=9
Age (mean value)	46.66	---	40
Gender	---	---	---
Female	6	---	5
Male	---	---	4
Role in the clinical education	---	---	---
Clinical mentor	3	1	2
Practical training coordinator	2	3	2
Faculty administrative staff	---		2
Link teacher	5	3	2
Nurse managers (ward nurse) / Hospital ward managers	2	2	1
IT department staff	---	1	---
University professors (School of nursing dean)	---	1	---

*Some stakeholders held several roles in practical training at the same time

Data collection and analysis

Focus groups took place between October – November 2022. Interviews were audio recorded, transcribed, and analyzed in the original language (Deutsch, Polish and Spanish). Then, results were translated into English. Each participant of the focus group was given a code/pseudonym to protect their anonymity.

Data collection and analysis were carried out simultaneously using the thematic content analysis proposed by Braun & Clarke (2012). The bottom-up approach was used to create firstly, very simple codes, to group them together, finding patterns, and inferring a higher level of meaning from successive readings. The findings are illustrated by verbatim excerpts from the focus groups.

2.3. Needs of students involved in practical training

Thematic analysis of the focus group transcriptions helped to identify six categories and 32 subcategories (Table 2).

Table 2. Categories and subcategories emerged from students' focus groups.

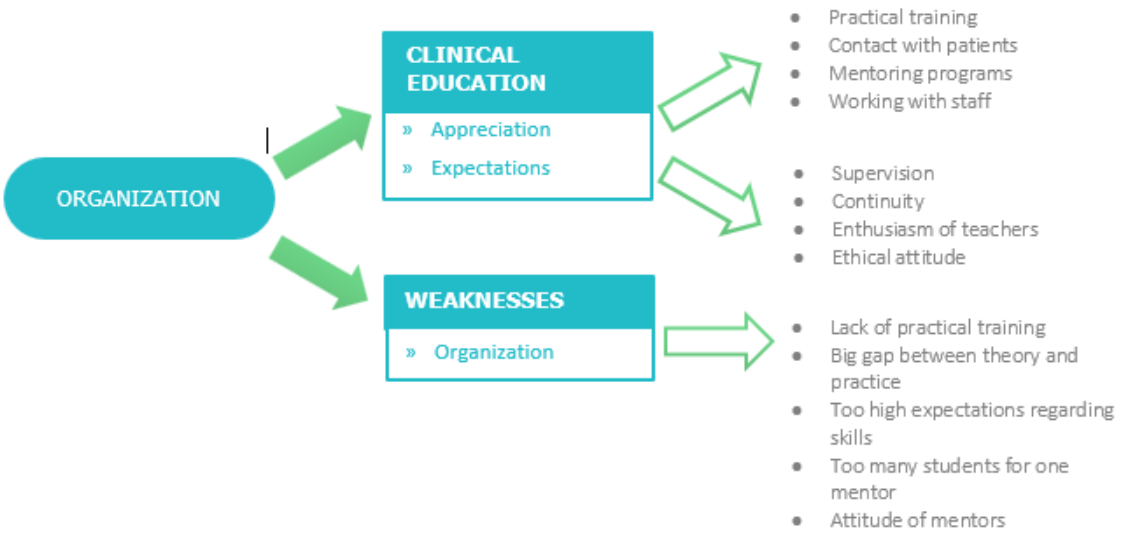
Category	Sub-category
Organisation of clinical education	- Appreciation of clinical education - Expectations regarding clinical education - Weaknesses in the organization of clinical education
Enthusiastic attitude toward mobile technology in clinical education	- Mobile technology as a future of clinical education - Useful Apps in clinical education
Benefits of using mobile technology in clinical education	- Mobile technology as a learning support - Customized learning - Application as a means of up-to-date and reliable knowledge - Mobile technology save time for direct care - Increasing patient safety and reducing variability during care
Expectations regarding mobile technology in clinical education	- Content wishes - Changing the way of learning - Organization of clinical education - Communication and welcoming/onboarding
Limitations of the use of mobile technologies in practical education	- Interpersonal relationship as fundamental of health care - It is only technology – it cannot be trusted - Ethical doubts - Aseptic issues - Lack of time in practice - Policies - Technical aspects - Resistance to change - Usage risks
Conditions for successful implementation of mobile technology into clinical education	- Technical issues - Changing attitude of older generation to m-technology and their earlier education - Promotion, training and commitment - Content issues - Involving students and stakeholders in the design

	- Funds - Issue of obligation - App as support of education - High level of product and for all students

Organisation of clinical education

Students appreciated that in their education there is a big number of hours of practical training and many possibilities of contact with patients. They indicated positively that they have training with mentors who have double roles, teach and do their clinical job at the same time and they can work together with staff. Students expect to have clinical/practical training under supervision of experienced practitioners and in interdisciplinary teams, who should be enthusiastic when teaching and have an ethical attitude when taking care of patients. At the same time, students indicated some weaknesses in the organization of clinical education. Students often highlighted that there is a big gap between theory and practice. There is no consistency between what they are taught at the university and what they see in reality. Moreover, some mentors do not have a positive attitude. For example, German students noticed that teaching is often understood as annoying by their mentors because of the workload and it is less "fun" as doing research. Students also indicated that there are too high expectations regarding practising some procedures. However, the ratio of clinical mentor/teacher – student is too high. In such circumstances, there is no possibility to see a procedure and practice it. All these results are reported in figure 3.

Figure3. Organization of clinical education.

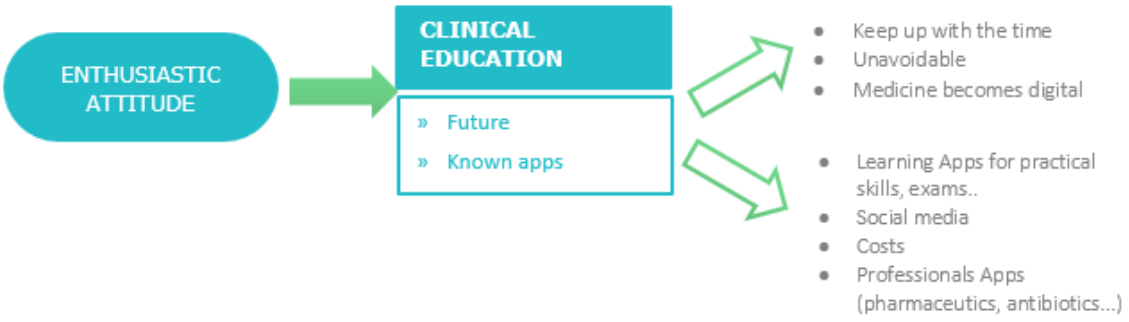


"Teaching is often perceived as a burdensome side job".

Enthusiastic attitude toward mobile technology in clinical education

In general terms, there is an enthusiastic attitude among students. Students underlined that mobile technology is the future of clinical training and education should keep up with the times. Students also reported there are many useful apps in clinical education such as anatomic atlases, apps for dose calculations, etc., which they use while in practice placements. These results can be seen in figure 4.

Figure 4. Enthusiastic attitude toward mobile technology in clinical education.

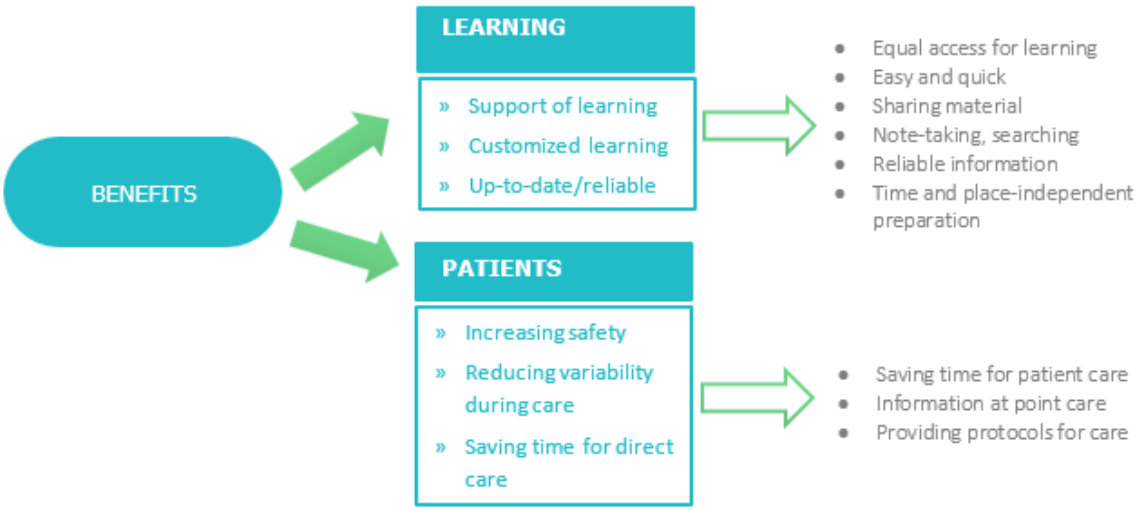


"... it is true that things are becoming more technological all the time...is always something beneficial if we use it for leisure [mobile technology], ... for work as well!".

Benefits of using mobile technology in clinical education

Students recognised many elements of mobile technology as a learning support, as it is shown in figure 5. They can access many learning resources, teachers and mentors can share with students materials for learning to be read at home or it can be used for notetaking and searching for reliable information at the point of care (at the patient bedside). Students also underlined that mobile technology could help in customising their learning. It would be also useful to track students' progress and to write notes and provide feedback everyday according to students' strengths and limitations. In this way students could focus on those areas that need to be improved. Additionally, it could be used to set challenges and competencies that students must achieve in order to motivate them and to organize their learning. Mobile technology can also increase patient safety and reduce variability during care because students can check clinical guides and protocols of each institution before going to the practice placement. In this sense, some students reported that each clinical mentor works differently, so if they could check the clinical guide before doing a procedure, they would feel more ready and confident. Finally, mobile technology saves time for direct care. Students complained about paperwork overload in health care. If they use tablets at patients' bedside to deal with documentation, it could help to save time for direct care and spend more time with patients.

Figure 5. Benefits of using mobile technology in clinical education.



"Our generation is definitely used to easier solutions and faster access to information, so any form of it on the phone or on the computer would be so much more natural for us...".

Expectations regarding mobile technology in clinical education

Students listed some expectations and uses that mobile technology should have when introducing it in practice placements, that are shown in figure 6. It could change the way of learning and increase the quality of practical training. With mobile technology, learning would become more flexible in time and place, but also in content use. Students could prepare at their own speed. Students indicated that mobile technology should be used to send homework and other activities and duties that students are expected to do during their rotations. Mobile technology could also help in the assessment of students, clinical mentors and practice placements.

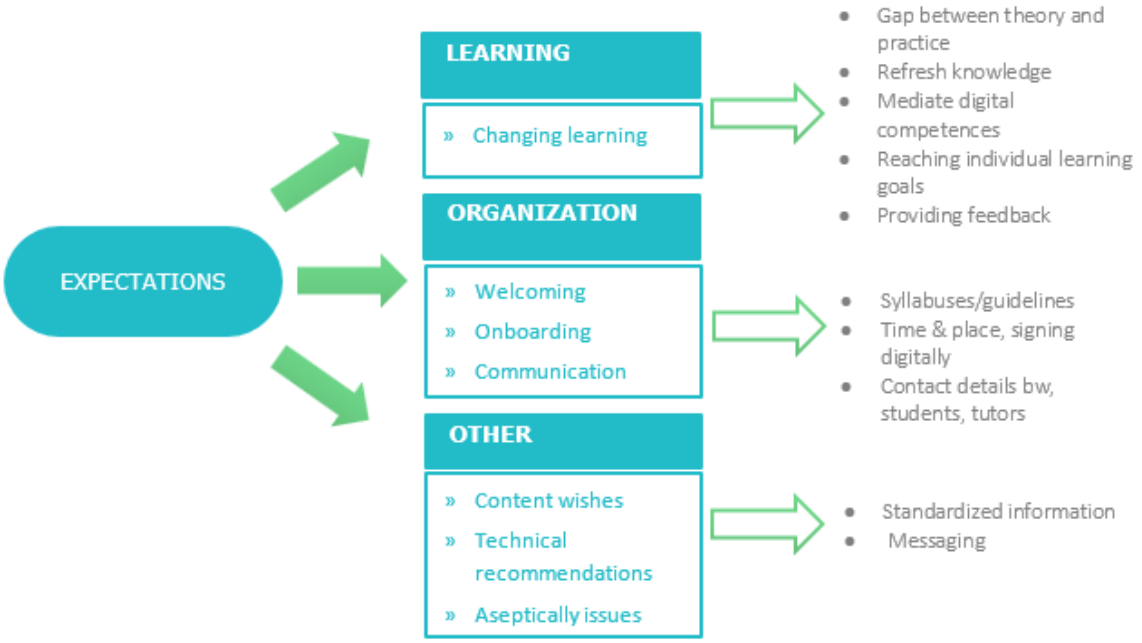
To help in the organisation of clinical education, mobile technology could contain syllabuses and would help in work with documentation. Additionally, students highlighted that the technology would be time-saving for clinical mentors and students because they would have all documentation in one place and mentors could assess students directly from their mobile phone or PC, sign digitally the attendance sheet, mandatory documents could be uploaded, etc.

Mobile Technology would also facilitate communication and welcoming/onboarding. Students imagine an instant messaging platform that could be used to communicate with other students and solve doubts, to communicate with clinical mentors, link teachers, practical coordinator or other actors involved in practice placements. Moreover, stakeholders could use it to communicate with students and to provide them important information about the practice placement before the rotation begins to increase student's confidence and to welcome them. Mobile technology also should include information about patient conditions of the unit and medical equipment, devices and material used. Moreover, the contact details of other peers to

know their experience in that practice placement, in this way the student could choose the practice placement according to previous experiences of other students.

Students listed some wishes regarding the content of an app for clinical training. Such technology should include clinical cases, anatomical atlases in 3D, videos, patient records, validated scales that are used during their rotations, a platform with job offers when students finish their education, etc.

Figure 6. Expectations regarding mobile technology in clinical education.



"... it is true that things are becoming more technological all the time...is always something beneficial if we use it for leisure [mobile technology], ... for work as well!".

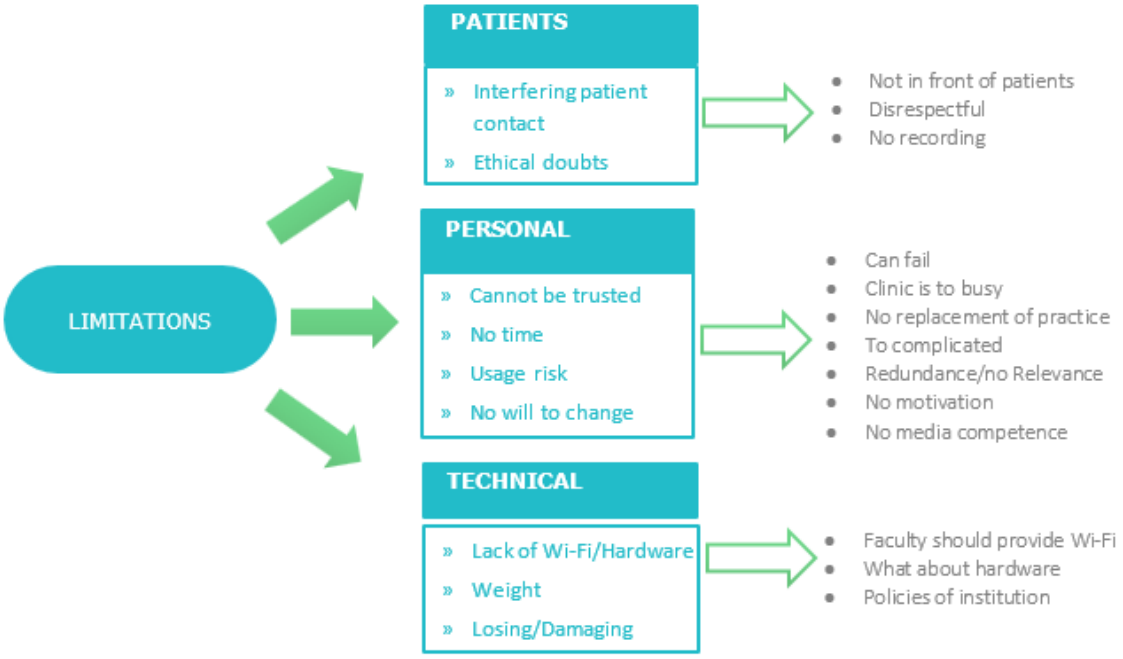
Limitations of the use of mobile technologies in practical education

Students reported several benefits and expectations regarding mobile technology in clinical education, but they also highlighted some limitations, which are listed in figure 7. For students, mobile technology could interfere with patient contact and interpersonal relationships, which are fundamental in healthcare. Moreover, they underlined that it is only technology and cannot be trusted and replaced their thinking and knowledge of basics. Apart from that, it entails some ethical doubts. Students indicated that using their phones in front of the patient could be perceived as disrespectful and unprofessional.

Students also underlined that clinical settings are often too busy to use mobile technology and some institutions do not allow the use of mobile devices or the use of their Wi-Fi. Students also mentioned that some devices are heavy and not comfortable to carry in their pocket all the time. Moreover, the device could be lost or damaged. Additionally, students emphasized that there could be a resistance to change among clinical mentors and staff. Mobile Technology

could be seen as an overwork and maybe clinical mentors would not want to teach students from the university that has implemented the technology. Moreover, students perceived a missing media competence especially in older teachers. Another risk is that the mobile technology might not be used by students if it is too complicated to use or if there is no or low relevance of the content.

Figure 7. Limitations of the use of mobile technologies in practical education.



"... it is true that things are becoming more technological all the time...is always something beneficial if we use it for leisure [mobile technology], ... for work as well!".

Conditions for successful implementation of mobile technology into clinical education

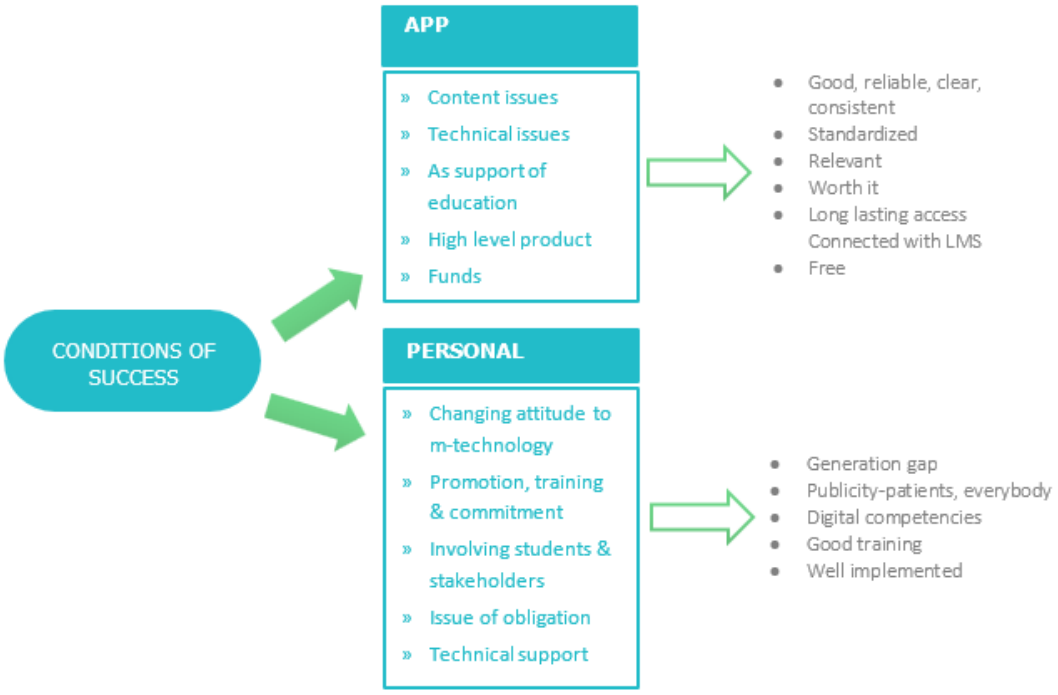
Students enumerated several issues which would make mobile technology interesting and worth to use, as shown in figure 8. They indicated that it should be easy to use, with a search engine like Google assistant, with the possibility to work offline. The content should be reliable, clear, consistent, and standardized with the same structure for every course. Students pointed out that it would be good to have a long-lasting access to the content. It should be linked to a learning management system like Moodle or the student administration system. These issues make Mobile Technology a useful tool as support of education, but it does not replace practical training. It would be also good if the device is not a mobile phone; students stated that a tablet could be more trusted by patients. Additionally, this device should have the logo of the University to look more professional.

The technology should have a user-friendly and easy interface and it should have different accesses and view modes according to the user profile (for students, clinical mentors, link teachers, etc.). It could be used with different software's (android, windows, etc.) and in different devices (mobile, tablet, PC, etc.). The technology/innovation/app should be the same for all students from different universities. Otherwise, it could be a barrier for clinical mentors to use it. Students also pointed out that the administrative and technical support should be sufficient.

To ensure a successful introduction of mobile technology in practice placements, there should be a change in the attitude of some stakeholders, especially the older generation. Students underlined that they should be trained about the possibilities of mobile technology and its usage. But training should be organized before its implementation, for all users. This training could lead to a better promotion and commitment of Mobile Technology. To guarantee a successful implementation, a teacher's enthusiasm would be also very important. There should be a commitment among all users, so the use of mobile technology should be mandatory. To encourage all users, especially clinical mentors, some compensation should be considered.

Promoting an innovative culture among patients and their families could also contribute to a successful implementation, so teachers and students should explain to them and involve them in using mobile devices and other technologies. The whole faculty should also support the implementation, so clear guidelines by the dean's office and a control authority should be set. Apart from that, all stakeholders should be involved in the process of co-creation and design of the mobile technology for clinical education. Moreover, sufficient funds should be considered to guarantee a successful implementation and mobile Technology should be free of charges for the final users.

Figure 8. Conditions for successful implementation of mobile technology into clinical education.



"It would be a good idea to organize some trial period, which then, if the application worked, and I suppose that in most cases it would, it would be a motivation to implement it."

2.4. Needs of stakeholders involved in practical training

Practical training has some limitations in its organization that stakeholders must consider. Stakeholders often cite limitations and risks when introducing and using mobile technologies in practical education. However, utilizing these technologies can also provide multiple benefits. Four categories and 22 sub-categories were identified after conducting the analysis.

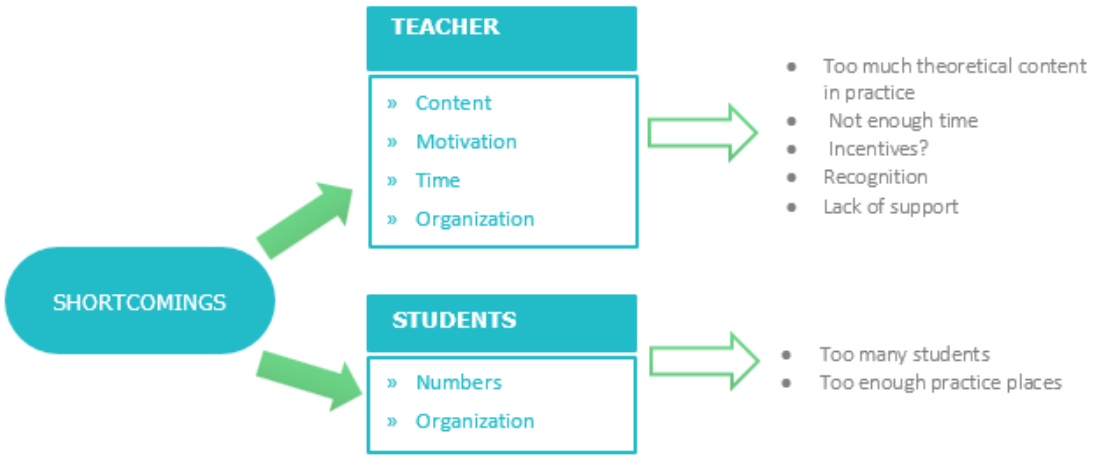
Table 3. Categories and sub-categories emerged from stakeholders focus groups.

Categories	Sub-categories
Shortcomings in the organization of practical training	Time limits for proper practical education
	Organizational challenges
	Little recognition and encouragement for clinical mentors
	Too many students, not enough places for internships
Benefits of using mobile technology in clinical education	Changing the way of learning and teaching - Quick and easy accessibility and portability - Self-directed learning - Reducing stress and anxiety - Simplifying paperwork and administrative procedures - Customizing student's learning and assessment
	Increasing patient safety and reducing variability during care
	Communication and onboarding
	Usage possibilities /Content wishes
Limitations and risks of mobile technologies in practical education	Lack of experience in using digital technology in clinical education
	Little support of hospital ward managers/staff when an innovation is proposed
	Interpersonal relationship is fundamental in health care
	Stigma
	Distraction and abusive use
Conditions for successful implementation of mobile technology into clinical education	Data protection
	Positive attitude
	Well organized process when designing the technology
	Content issues
	Close cooperation with IT department
	Technical issues and conditions in wards
	Student’s issues
	Funds

Shortcomings in the organization of practical training

Stakeholders reported that there are time limits for proper practical education and students often arrive at practice placements with insufficient theoretical knowledge, making it difficult for them to fully develop certain skills during practical training. Moreover, sometimes there are not enough places for internships, so there are too many students in the same clinical placement. Additionally, the involvement of multiple actors in practice placements can lead to organizational challenges of practical training. Clinical mentors play an important role but they often receive little recognition reducing their motivation and engagement. These results are reported in figure 9.

Figure 9. Shortcomings in the organization of practical training.



"What I see in the end is the lack of recognition that the clinical tutor has...we should try to motivate her, to encourage her to do this training to integrate digitization in her process."

Benefits of using mobile technology in clinical education

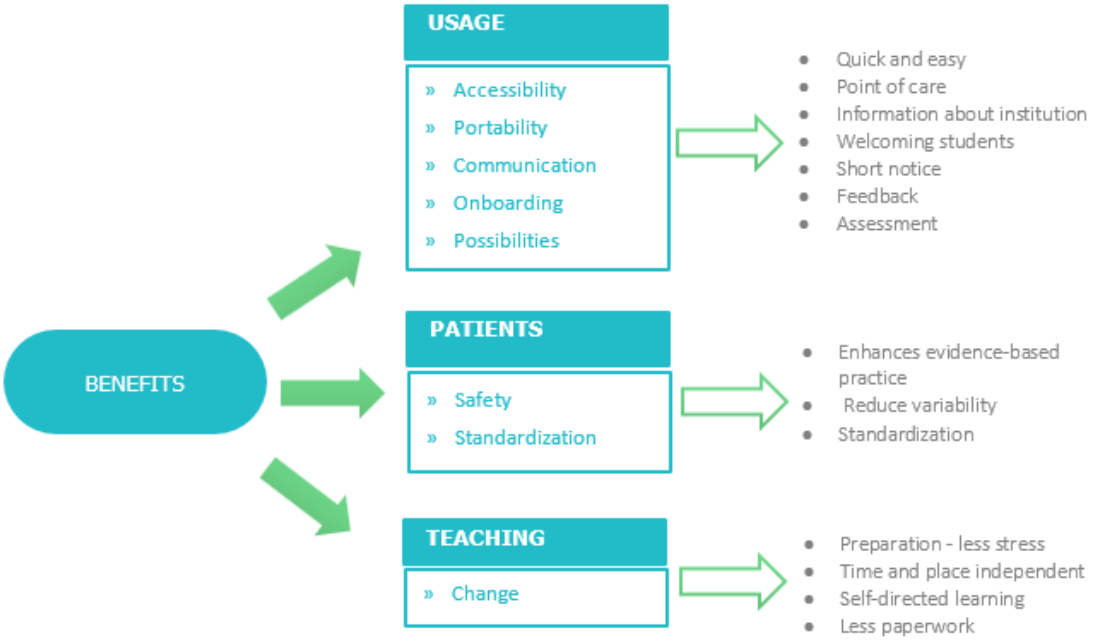
The results from stakeholders focus groups show that mobile technology into clinical education in practice placements can offer many benefits and has the potential to change the way of learning and teaching (see figure 10). Quick and easy accessibility and portability, access to up-to-date information at the bedside, reducing stress and anxiety by providing learning resources to students such as videos, drug databases or other apps, are some of the usages that mobile devices may have. Another benefit reported by stakeholders is that mobile technology can also assist in the assessment of students during practice placements. It simplifies the process of collecting and evaluating student performance by providing a centralized location for all documentation, such as assessment sheets, procedures, and other relevant information. Mobile technology can also be used to track students' progress and collect data on the skills and competencies that students have acquired in previous practice placements. Additionally, it can

also provide insight on a student's learning style, preferences and strengths, which can be used to design customized educational activities, learning objectives and assessments that align with a student's specific needs. Additionally, it can also simplify administrative procedures and reduce the need for paperwork, for example facilitating the process of signing attendance sheets digitally.

Mobile technology can also facilitate communication among the various actors involved in practice placements, such as students, university professors, clinical mentors, hospital ward managers and other staff. This can improve the coordination and communication among all stakeholders, which can lead to a more efficient and effective onboarding experience for students. Additionally, mobile technology can be used to provide students with information about the institution that is hosting them, and to welcome them to the practice placement.

Mobile technology can also standardize the way of learning practical procedures and teaching which is agreed upon by the different institutions that host students. This can help to reduce variability during care and increase patient safety. Mobile technology can also enhance evidence-based practice by providing students with up-to-date and accurate information, guidelines and protocols.

Figure 10. Benefits of using mobile technology in clinical education.

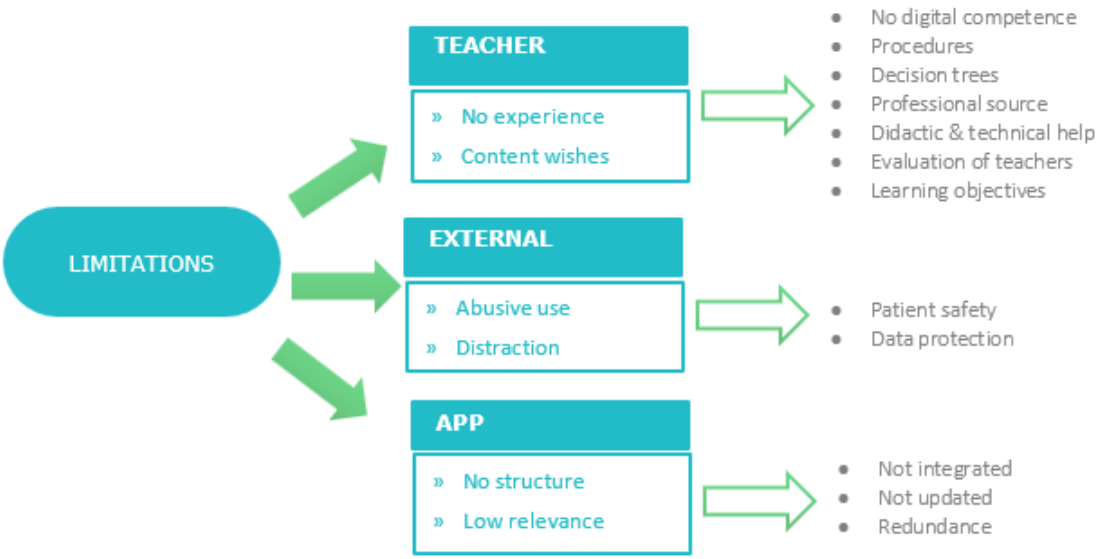


"...then you can start a completely different point and just do a lot more hands on and have a lot less to do with the minute explanation of the theory."

Limitations and risks of mobile technologies in practical education

Stakeholders also reported that using Mobile Technology in practice placements also entails some challenges and has some limits (see figure 11). First, there is a lack of experience in using digital technology in clinical education and little support from hospital ward managers and staff when any innovation is proposed, as it can be seen as an overload and lead to resistance to change. There can also be a perceived stigma among patients and healthcare professionals when mobile devices are used in the clinical area. On the other hand, for stakeholders, interpersonal relationships are fundamental in healthcare, so it is important to note that mobile technology should not be seen as a replacement for direct contact with patients. Distraction and abusive use are other risks. If students get distracted while using mobile technology in a clinical setting, it can pose a risk to patient safety. Finally, data protection is a crucial aspect that should be taken into consideration when developing and implementing mobile technology in clinical education. Both user and patient data must be protected and treated with the utmost confidentiality and privacy.

Figure 11. Limitations and risks of mobile technologies in practical education.



"So as preparation I think it's nice if there's a rough procedure or for the teachers so that they know what the contents are, what I should teach…".

Conditions for successful implementation of mobile technology into clinical education

As Mobile Technology may have several limitations when introducing it in practice placements, stakeholders highlighted some conditions that can contribute to successful implementation (see figure 12). The most often underlined condition was digital education, promotion and training among students and healthcare professionals to use digital tools properly. This promotion can make them find mobile technology useful and beneficial and encourage them to use it. It is also necessary for patients in order they view mobile technologies as useful tools for their care. Through this promotion and training stakeholders and students can develop a positive attitude to the use of mobile technology in clinical education. For example, clinical mentors and

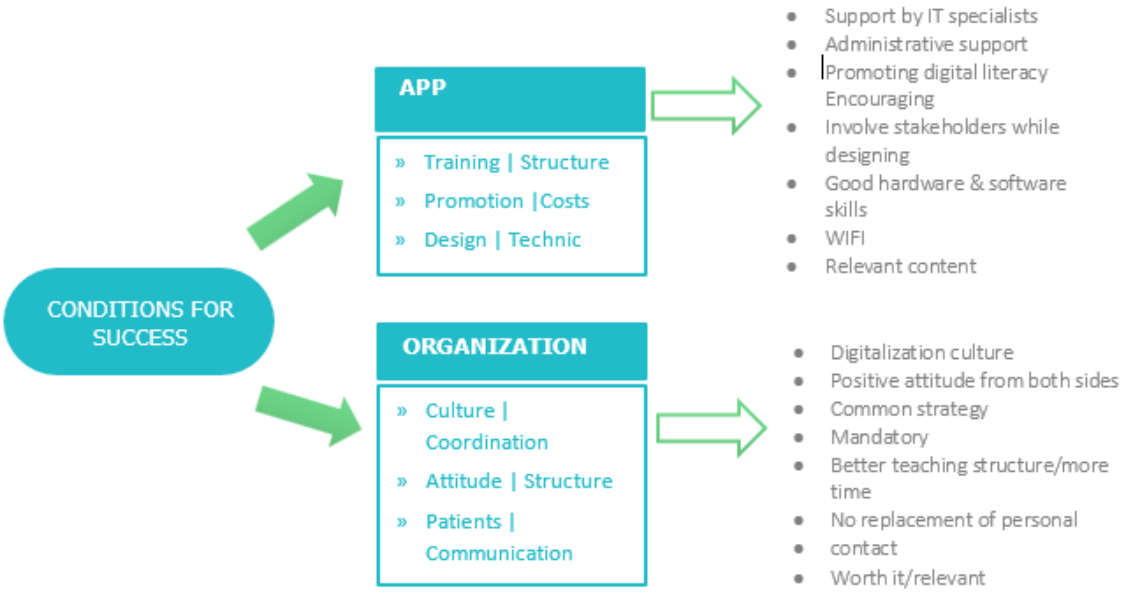
university teachers could see that technology reduces time when assessing students, when communicating with other stakeholders and helps them to organize their clinical education.

Counting on the support of hospital ward managers is also essential to guarantee a successful implementation in wards. If the practice placement has a digitalization culture, students and stakeholders would be more motivated to use technologies.

Technology will not be successful if it is not integrated in a course in a didactic meaningful way and it will not be used in the long term when it is not updated on a regular basis. In this sense, teachers and other stakeholders involved in clinical education and other users of the innovation should be involved when designing and introducing changes in the technology. The design and the use of the app needs to be self-explanatory and there should have a friendly and easy-use interface. It also should be provided clearly, be valid, updated and evidence-based, present important themes, there should be consistency through the app, its presentation should be standardized, and it should be controlled by educators. So, the app may be divided into two parts: one for stakeholders (university teachers and clinical mentors) and another for students. There should be constant contact and cooperation with the IT department when designing the digital tool and during its usage in practice placements to detect some technical problems and introduce improvements. Moreover, stakeholders indicated that it should be earlier piloted to check how it works. The innovation should include good hardware and software and have a good server and be updated regularly. The technology could be used in different devices (mobile phones, tablets, PC, etc.) and there should be one password to all devices. Moreover, there should be enough structures to guarantee a proper digitalization in wards, such as Wi-Fi coverage and access.

Developing and implementing an innovation entails high costs. All stakeholders indicated that funds are very important on each stage of implementation and designing mobile technology. Additionally, the introduction of technology should not imply any charges for the final users.

Figure 12. Conditions for successful implementation of mobile technology into clinical education



"...that we may need a period of adaptation, but the moment a professional see that it reduces his time to evaluate the student, follow up, be in contact with the academic tutor. And it has everything available. ...will surely use it."

3. Conclusions

The introduction of mobile technology into clinical education can be beneficial for healthcare students and stakeholders involved in practical education. However, it also entails some challenges that must be considered.

The literature review and results from students and stakeholders focus groups have converged to identify specific factors that facilitate and difficult the implementation and use of mobile technologies in clinical education. These results showed that mobile technology is not widely used in medical and health sciences clinical education therefore the aim of the project and partnership is justified, and action needed. This also suggests that there is a growing body of evidence that can inform the design and implementation of mobile technology-based educational interventions in this context. Identifying factors that facilitate or hinder the adoption and use of mobile technologies in clinical education is critical to ensuring the success of these interventions.

Some of the factors that have been identified in the literature and focus groups that facilitate the use of mLearning in practice placements are improving access to clinical resources, enhancing communication and collaboration among healthcare professionals, students and stakeholders and facilitating self-directed learning.

In general terms, mobile technologies and the possibility of their use in clinical education are positively assessed by both students and different stakeholders involved in the education process. Moreover, taking into account the characteristics of Generation Z and their natural digital competences, the use of mobile technologies in clinical education will be conducive to improving the effectiveness of learning and the development of clinical skills. So, the natural digital competencies of Generation Z can be leveraged through the use of mobile technologies, making it easier for them to learn and develop their skills.

Mobile technology also has the potential to transform the way medical and health sciences education is delivered, making it more accessible, engaging, and efficient. Moreover, mobile apps can provide a platform for students and educators to access educational resources and tools anytime and anywhere, as well as facilitate collaboration and communication among learners and instructors.

Taking into account the results of literature analysis and the findings of our qualitative research, mobile technology has a chance to improve the organization of clinical education and improve communication between all parties involved in the process of practical education.

While introducing mobile technology into clinical education in practice placement can offer many benefits, it is important to address potential barriers and ensure that students and healthcare professionals are provided with the necessary training and support to effectively use these tools. The often-indicated problems when introducing mobile technology in medical and nursing education is that designing the product is out of the hands of learners and their teaching staff and without considering the cultural acceptance, social norms governing the use of mobile devices in clinical settings and the lack of clear policies. Additionally, mobile devices are introduced with insufficient consideration of course content or needs at the institutional level, including both sufficient Wi-Fi coverage and the alignment and capacity of teaching staff to use mLearning. Therefore, to ensure successful implementation of mLearning into clinical training clear strategy should be developed. Additionally, identifying tips on how to avoid problems or solve them is also crucial.

In short, the successful integration of mobile apps in clinical education requires careful planning and consideration of various factors. Therefore, the project and partnership aimed at promoting the use of mobile apps in clinical education can be seen as a valuable initiative that could have a positive impact on the quality and effectiveness of medical and health sciences education.

Overall, the convergence of findings from the literature review and own qualitative study provides valuable insights into the factors that can promote or hinder the adoption and use of mobile technologies in clinical education and offers practical tips for addressing potential challenges. These findings can help inform the development of effective strategies for introducing and implementing mobile technology-based educational interventions in clinical education.

On the other hand, results from our literature review and focus groups show that the use of mobile technology in medical and health sciences clinical education is not yet widespread. This suggests that there is a need for action to address this gap, and the aim of the 4D project and partnership to promote the use of mobile apps in clinical education is therefore justified.

Co-designing a mobile learning application that reflects users' core values and needs is essential to the successful adoption of mobile technology in practice-based learning. The results from the literature review and the focus groups provided can give valuable insights into users' needs, values, and preferences. This can inform the design of the app and ensure that it is user-centered.

In conclusion, successful digitalization of practice-based learning in healthcare higher education requires careful consideration of the facilitators and barriers. By addressing the challenges and leveraging the facilitators, educators and other stakeholders can develop effective and innovative digital learning strategies that can enhance the quality of healthcare education.

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