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Use of a mobile application for learning evidence-based practice: A multi-method approach

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Scientific environment

This doctoral project was completed between 2018 and 2023 at the Department of Health and Functioning, Western Norway University of Applied Sciences (HVL), Bergen, and I was enrolled as a PhD student in the PhD programme Health, Function, and Participation. The Ministry of Knowledge scholarship and HVL funded the research.

The main supervisor and initiator of this PhD project was Nina Rydland Olsen, Associated Professor and head of the Evidence-Based Practice section at the Department of Health and Functioning, HVL. The co-supervisors were Associated Professor Lillebeth Larun at the Division of Health Services, Norwegian Institute of Public Health, Oslo, Professor Birgitte Espehaug at the Department of Health and Functioning, HVL, and Professor Emerita Donna Ciliska at the Faculty of Health Sciences, McMaster University, Hamilton, Canada.

During my PhD, I participated in two research groups affiliated with HVL: the educational research in health and social sciences professions research group and the implementation and methodology research group. Furthermore, the 25% position of work duty during my PhD scholarship was completed at the Occupational Therapy Education programme, HVL.

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Bergen, 12. January 2024

Susanne Grødem Johnson

Abstract

Introduction

Evidence-based practice (EBP) involves making informed decisions about the best patient care. Practicing and learning EBP is guided by the following five steps: asking questions (Ask), searching for research evidence (Access), critically appraising the evidence (Appraise), applying the evidence (Apply), and evaluating the EBP process (Audit). EBP teaching interventions should be interactive, multifaceted, clinically integrated, and assessed. While digital technology and mobile applications (apps) are relevant in facilitating interactive learning, few examples exist within EBP. A mobile app called *EBPsteps* was developed to support interactive EBP learning in health and social care education in Norway. Usability testing, alongside the development of learning apps, is needed to ensure that apps are user-friendly and relevant. To our knowledge, few previous studies have investigated the usability of EBP apps.

Aims

The overall aim of this thesis was to enhance our knowledge of how health and social care students use a new and innovative mobile app learning EBP. In addition, the aim was to broaden our understanding of methods and attributes relevant to usability studies of mobile apps for health care education.

Methods

This thesis employed a multi-method approach, which included three studies with different designs. Health and social care students' experiences of learning EBP using the mobile app *EBPsteps* during their clinical placements were explored in an interpretive description study (Paper I). EBP skills, as reported through the mobile app *EBPsteps*, were assessed among four occupational therapy (OT) student cohorts in a cross-sectional study (Paper II). Usability methods and attributes applied in usability studies of mobile apps for health care education were identified in a scoping review (Paper III).

Results

Paper I: We found that students experienced triggers and barriers towards using the *EBPsteps* app. Triggers identified were information needs, academic requirements, and expectations from clinical instructors to use EBP during clinical placement. Barriers identified were insufficient EBP knowledge, the absence of academic demands, and clinical instructors not expecting students to apply EBP in practice. The design features of the app also affected students' use of

the app. Students experienced that the app provided a useful overview of the EBP steps and functioned as a digital notebook. However, when students encountered technical problems such as difficulty in navigation and unfamiliar icons, it negatively impacted their use of the app.

Paper II: Among 150 OT students, 119 (79%) used the *EBPsteps*, and they produced 240 Critically Appraised Topics (CATs). We found that most students were able to perform the first EBP steps (Ask, Access, and Appraise). A positive association was found between formulating the PICO/PICO elements and identifying research evidence. Most of the students were not able to report the two final EBP steps correctly (Apply and Audit).

Paper III: The scoping review consisted of 88 articles that encompassed 98 studies, primarily centered on nursing and medical students. The most common usability methods identified were inquiry methods that included the use of questionnaires. The most frequently reported usability attributes were satisfaction, usefulness, and ease of use.

Conclusion

We found that students used the *EBPsteps* app when they were required to do so, either in EBP assignments or during clinical placement (Paper I). The lack of EBP knowledge and design features of the app hindered its use. We found that students struggled to report the EBP steps Apply and Audit when using *EBPsteps* (Paper II). The reason behind this could be a lack of EBP competence, low technology literacy, design features of the app, or cognitive load. A limited range of usability methods was used to evaluate health care educational apps, and the most used attributes were satisfaction, usefulness, and ease of use (Paper III). Selecting a wider variety of usability methods and attributes when conducting a study can provide more thorough usability testing.

According to the findings in Paper III, both objective and subjective usability methods are necessary, and researchers must select relevant attributes to examine when conducting a usability study. To further evaluate the *EBPsteps* app's usability, future research should perform cognitive interview studies, such as think-aloud methods and other pilot studies. Only students were included in the first two studies of this thesis (Papers I and II), and as such, future studies are needed to test the usability of *EBPsteps* among other populations. Therefore, future research should examine how teachers implement the use of *EBPsteps* in their teaching practices.

This doctoral project was completed between 2018 and 2023 at the Department of Health and Functioning, Western Norway University of Applied Sciences (HVL).

Norsk sammendrag (Abstract in Norwegian)

Introduksjon

Kunnskapsbasert praksis (KBP) innebærer å ta informerte beslutninger slik at pasienter får den beste omsorgen. Å praktisere og lære KBP er veiledet av følgende fem trinn: stille spørsmål (Spørre), søke etter forskning (Søke), kritisk vurdere forskningen (Vurdere), anvende forskningen (Anvende) og evaluere KBP prosessen (Evaluere). KBP undervisning bør være interaktive, variert, klinisk integrerte og vurdert. Digital teknologi og mobilapplikasjoner (apper) kan bidra til interaktiv læring, men det finnes få eksempler på dette innen KBP. En mobilapp kalt *EBPsteps* ble utviklet for å støtte interaktive opplæring i KBP for helse- og sosialfagutdanninger i Norge. Når en utvikler læringsapper, må brukertesting foregå parallelt for å sikre at appene er brukervennlige og relevante. Så vidt vi vet har få tidligere studier undersøkt brukervennlighet av apper for KBP.

Hensikt

Hensikten med denne avhandlingen var å styrke vår kunnskap av helse- og sosialfagstudenters læring av KBP ved bruk av en ny og innovativ mobil app. Videre hadde prosjektet som hensikt å utvide vår forståelse av brukertestingsmetoder og brukervennlighetsegenskaper som er relevante ved brukertestingsstudier av mobil apper for helsefaglige utdanninger.

Metode

Denne avhandlingen anvendte en multimetode tilnærming som inkluderte tre studier med ulik design. Helse- og sosialfag studenters erfaringer med å lære KBP ved hjelp av mobilappen *EBPsteps* i praksis ble utforsket i en fortolkende beskrivelse studie (Artikkel I). KBP ferdigheter, som var rapportert ved bruk av *EBPsteps*, ble vurdert i en tverrsnittstudie bestående av fire kohorter med ergoterapistudenter (Artikkel II). Brukertestingsmetoder og brukervennlighetsegenskaper brukt i studier som hadde gjennomført brukertesting av mobilapper for helseutdanninger ble identifisert i en kartleggingsstudie (Artikkel III).

Resultater

Artikkel I: Vi fant at studenter opplevde triggere eller barrierer til å bruke *EBPsteps* appen. Triggere som ble identifisert var informasjonsbehov, akademiske krav og forventninger fra veiledere til å bruke KBP i praksis. Barrierer vi identifiserte var manglende KBP kunnskap, fravær av akademiske krav og veiledere som ikke forventet at studentene skulle anvende KBP i praksis. Designet av appen påvirket også studentenes bruk av appen. Studentene opplevde at

appen gav en nyttig oversikt over KBP trinnene og at den fungerte som en digital notatbok. Men når studentene opplevde tekniske problemer som vansker med navigering og ukjente ikoner, så var det vanskeligere å bruke appen.

Artikkel II: Blant 150 ergoterapistudenter, så brukte 119 (79%) *EBPsteps* og de produserte 240 Kritisk Vurderte Tema (CATs). Resultatene viste at studentene i stor grad var i stand til å fullføre de første trinnene av KBP prosessen (Spørre, Søke og Vurdere). Vi fant også en assosiasjon mellom formulering av PICO/PICo elementer og identifisering av forskningsresultater. De fleste studentene rapporterte ikke de to siste trinnene av KBP prosessen (Anvende og Evaluere).

Artikkel III: Kartleggingsstudien inkluderte 88 artikler med totalt 98 studier, hovedsakelig knyttet til sykepleie og medisinstudenter. De vanligste metodene var undersøkelsesmetoder som inkluderte bruk av spørreskjema. De hyppigst rapporterte brukervennlighetsegenskaper var tilfredshet, nytte og brukervennlighet.

Konklusjon

Vi fant ut at studentene brukte appen *EBPsteps* når de ble pålagt det, enten i KBP oppgaver eller i praksis (Artikkel I). Mangelen på KBP kunnskap og designet av appen hindret bruk av appen. Vi fant ut at studentene hadde vansker med å rapportere KBP trinnene Anvende og Evaluere når de brukte *EBPsteps* (Artikkel II). Årsaken til dette kan være mangel på KBP kompetanse, lav teknologikompetanse, designet av appen eller kognitiv belastning. En begrenset variasjon av brukertestingsmetoder ble brukt til å evaluere undervisningsapper innen helseutdanninger og de mest brukte brukervennlighetsegenskapene var tilfredshet, nytte og brukervennlighet (Artikkel III). Å velge et bredere utvalg av brukertestingsmetoder og brukervennlighetsegenskaper ved gjennomføring av en studie kan bidra til en grundigere brukervennlighetstesting.

Ifølge funn fra Artikkel III er det nødvendig med både objektive og subjektive brukertestingsmetoder, og forskere må velge relevante brukervennlighetsegenskaper å undersøke når de gjennomfører en brukervennlighetsstudie. For ytterligere å evaluere *EBPsteps* appens brukervennlighet, bør fremtidig forskning utføre kognitive intervjustudier, for eksempel tenke-høyt tester og andre pilotstudier. Det var kun studenter som ble inkludert i de to første studiene av denne avhandlingen (Artikkel I og II). Der er derfor nødvendig i fremtidige studier å teste brukervennligheten til *EBPsteps* blant andre populasjoner, hvor fremtidig forskning bør undersøke hvordan lærere bruker *EBPsteps* i sin undervisningspraksis.

Dette doktorgradsarbeidet ble gjennomført mellom 2018 og 2023 på institutt for helse og funksjon, Høgskulen på Vestlandet (HVL).

List of publications

Paper I Johnson S.G., Titlestad K.B., Larun L., Ciliska D., & Olsen N.R. (2021). Experiences with using a mobile application for learning evidence-based practice in health and social care education: An interpretive descriptive study. *PLoS One, 16(7)*, e0254272. https://doi.org/10.1371/journal.pone.0254272

Paper II Johnson S.G., Espehaug E., Larun L., Ciliska D., & Olsen N.R. (2023). Occupational therapy students' evidence-based practice skills as reported in a mobile app: A cross-sectional study. *JMIR Medical Education*, Submitted September 2023

Paper III Johnson S.G., Potrebny T., Larun L., Ciliska D., & Olsen N.R. (2022). Usability methods and attributes reported in usability studies of mobile apps for health care education: Scoping review. *JMIR Medical Education, 8(2),* e38259, https://doi.org/10.2196/38259

Table of Contents

Scientific environment....3
Acknowledgments....4
Abstract....6
Norsk sammendrag (Abstract in Norwegian)....8
List of publications....10
Table of Contents....11
Appendices....13
List of tables....13
List of abbreviations....14
1. Introduction....15
1.1 Evidence-based practice....16
1.2 The process of evidence-based practice: The five-step model....18
1.3 Teaching and learning evidence-based practice....21
1.4 Assessment of evidence-based practice teaching and learning....23
1.5 Use of technology for learning and assessing evidence-based practice....25
1.6 Usability testing of mobile apps....27
1.7 The context of this thesis....30
1.7.1 The *EBPsteps* mobile app....30
2. Aims....33
3. Materials and methods....34
3.1 Study designs (Papers I–III)....34
3.2 The qualitative study (Paper I)....35
3.3 The quantitative study (Paper II)....39
3.4 The scoping review (Paper III)....41
3.5 Ethical and legal issues (Papers I-III)....43
4. Summary of findings....44
4.1 Paper I....44
4.2 Paper II....46
4.3 Paper III....47
5. Discussion....48
5.1 Methodological considerations....48
5.1.1 Overall design....48

5.1.2 The qualitative study (Paper I)....49
5.1.3 The quantitative study (Paper II)....53
5.1.4 The scoping review (Paper III)....56
5.2 Discussion of key findings....58
5.2.1 Students need triggers to use the *EBPsteps* app....58
5.2.2 Students lack the necessary skills to follow the EBP steps Apply and Audit....60
5.2.3 Educational apps must be easy to use, but training is needed....61
5.2.4 Various usability methods are necessary to understand the usability of an app....63
5.2.5 Researchers must select appropriate and relevant usability attributes....64
6. Conclusion and implications....66
7. Future research....67
References....69

Papers I-III

Appendices

Appendices

Appendix 1: Interview guide (Paper I)

Appendix 2: The scoring plan of the *EBPsteps* (Paper II)

Appendix 3: Protocol for the scoping review (Paper III)

Appendix 4: NSD Approval (Papers I–II)

Appendix 5: Sikt Approval (Papers I–II)

Appendix 6: Consent form (Paper I)

List of tables

Table 1: Skills needed to perform the five EBP steps

Table 2: Frequently applied usability attributes

Table 3: Content of the *EBPsteps* mobile app

Table 4: Overview of methodology (Papers I-III)

Table 5: Number of participants in the focus groups and EBP sessions they had received

Table 6: Illustration of the analysis process across interviews

Table 7: Themes and subthemes with quotes from Paper I

Table 8: Correctly reported PICO/PICo elements

List of abbreviations

APPs	Mobile applications
CASP	Critical Appraisal Skills Program
CATs	Critically Appraised Topics
CREATE	The Classification Rubric for EBP Assessment Tools in Education
EBHC	Evidence-Based Health Care
EBM	Evidence-Based Medicine
EBP	Evidence-Based Practice
ECTS	European Credit Transfer and Accumulation System
FHS	Faculty of Health and Social Sciences
HVL	Western Norway University of Applied Sciences
OT	Occupational Therapy
PBL	Problem-Based Learning
PDF	Portable Document Format
PICO	Population (P), Intervention (I), Comparison (C), and Outcome (O)
PICo	Population (P), Interest (I), and Context (Co)
PRESS	Peer Review of Electronic Search Strategies
PT	Physiotherapy
RCTs	Randomised Controlled Trials
SE	Social Education
SUS	System Usability Scale
TPACK	The Technological Pedagogical Content Knowledge

1. Introduction

The volume of health care research publications is growing rapidly (Curcic, 2023; Sau & Nayak, 2022). With this growth, health professionals face a rise in challenges in navigating this wealth of information (Bastian et al., 2010; Hoffmann et al., 2017, p. 17). In the past five years alone, Medline has cited around 1 million new publications annually (National Library of Medicine, 2023), making it a struggle for health care professionals to stay up to date. The problem is compounded for practitioners and patients alike by the ever-increasing problem of fake news and clickbait (Bolton & Yaxley, 2017). Furthermore, much of the published research is of varying quality (e.g. Hoffmann et al., 2017, p. 9; Ioannidis, 2005, 2016). Accordingly, practitioners must learn to critically evaluate information and distinguish between reliable and unreliable research and information before determining if it can be used to advance clinical practice (Hoffmann et al., 2017, p. 9).

One solution to the issues above is the use of an evidence-based practice (EBP) approach. This approach can support practitioners in making clinical decisions based on patients' preferences and the best available research evidence (Dawes et al., 2005). The aim of EBP is to make informed decisions about the best and most appropriate care for each patient (Hoffmann et al., 2017, p. 6). EBP may also support the process of distinguishing evidence from propaganda and science from folklore (Dawes et al., 2005) and prevent wastage of limited health care resources on ineffective treatments (Walewska-Zielecka et al., 2021).

To learn EBP and to ensure effective learning outcomes, teaching and learning interventions should be interactive, multifaceted, and related to clinical practice (Bala et al., 2021). To support the learning processes, an assessment of the students' EBP learning outcomes should also be included (Bala et al., 2021). The systematic review conducted by Kyriakoulis et al. (2016) found that the use of mobile apps could facilitate effective EBP teaching and learning for undergraduate students. However, research on the use of mobile apps when learning EBP has been limited (Larsen et al., 2019), and their effectiveness is still uncertain (Patelarou et al., 2020).

1.1 Evidence-based practice

EBP builds on the paradigm of evidence-based medicine (EBM) that was introduced in the early 1990s. EBM evolved as a response to clinical decisions being based on intuition and unsystematic clinical experience, as opposed to practice being based on research evidence (Guyatt et al., 1992). One often cited definition of EBM was provided by Sackett et al. (1996):

> Evidence based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research. (Sackett et al., 1996, p. 71)

Since the 1990s, EBM has evolved and been embraced across professions. To acknowledge this expansion, it was suggested that the concept of EBM be broadened and referred to as EBP (Dawes et al., 2005). Delegates at the international conference of Evidence-Based Health Care Teachers and Developers held in Sicily in 2003 suggested the following definition of EBP:

> Evidence-Based Practice (EBP) requires that decisions about health care are based on the best available, current, valid and relevant evidence. These decisions should be made by those receiving care, informed by the tacit and explicit knowledge of those providing care, within the context of available resources. (Dawes et al., 2005, p. 4)

Despite the fact that the concept of EBP was created to ensure relevancy across disciplines, related terms are sometimes used, including evidence-based health care (EBHC), evidence-based occupational therapy, evidence-based physiotherapy, and evidence-based social work (Chloros et al., 2022; Schulte, 2020). While these terms have slightly different meanings, they all involve adopting an evidence-based practice approach. Throughout this thesis, the term EBP will be used. The word ‘patient’ will be used in this text, but it is important to note that other terms such as ‘client’, ‘consumer’, or ‘user’ (among others) may be more appropriate in certain contexts. The following sections will provide a brief explanation of how the best available research evidence, the patient’s knowledge and values and clinical expertise are understood in the context of EBP, including the decision-making process involved in the EBP process.

The best available research evidence

When making decisions in practice, it is essential to rely on the most trustworthy research evidence available (Dawes et al., 2005). Decisions must be grounded on unbiased, relevant, and transferable evidence that can be applied to the clinical setting (Melnyk & Fineout-Overholt, 2023, p. 11). This means that the evidence must be as unbiased as possible to be trusted, and the setting and people of the study must resemble the individual patients for the evidence to be applicable in practice (Polit & Beck, 2021, pp. 36–37). Before applying research evidence in practice, the practitioner needs to determine whether the study methods are reliable and valid enough to be trusted (Hoffmann et al., 2017, p. 10).

Several different types of clinical questions can be answered through research evidence, with the use of different designs depending on the questions asked, such as diagnosis, prognosis, aetiology, prevalence, treatment, or patient experiences (Hoffmann et al., 2017, p. 18). For instance, for therapy questions, the least biased evidence will come from systematic reviews of randomised controlled trials (Polit & Beck, 2021, p. 29), whereas for questions of experiences or attitudes, a qualitative research approach will be most appropriate (Hoffmann et al., 2017, p. 31).

Patients' knowledge and values

Relying solely on research evidence is insufficient, however, as patient involvement is crucial for effective care (Tikkinen & Guyatt, 2021). According to Dawes et al. (2005), those receiving the care should make decisions about the health care provided. Greenhalgh et al. (2014) recommend that health care professionals begin the evidence-based process by understanding the patient's life situation, in order to understand what is important to the patient.

According to Haynes et al. (2002), clinical practice can be improved when the knowledge and wishes of the patients are considered. Practitioners should adopt patient-centered care, which involves being respectful and responsive to patients and letting them guide their healthcare decisions (Melnyk & Fineout-Overholt, 2023, p. 182). Patients must make decisions about their care, but to help them make informed decisions, the practitioners must provide information on the possible benefits or harms of available treatments (Tikkinen & Guyatt, 2021).

Clinical expertise

Practitioners use their clinical skills and experience to make decisions in practice (Straus et al., 2019, p. 1). They need to gather and interpret information from various sources, including research evidence and patients' preferences, reactions, and outcomes while building on their existing knowledge base to make decisions under conditions of uncertainty (Hoffmann et al., 2017, p. 365). To apply an evidence-based approach, clinical reasoning that combines the "art" of the profession and the research evidence is necessary (Hoffmann et al., 2017, p. 380). Clinical reasoning can be understood as decisions made in practice based on the complex thinking of the practitioners (Higgs et al., 2019). As early as 1996, Sackett et al. (1996) advocated for research evidence to inform but not replace individual clinical expertise in decision making, as practitioners need to determine if the research evidence applies to their patients.

Evidence-based decision making

Shared decision-making is an important part of the EBP decision-making process, where the appraised research evidence is integrated with the patient's values and the practitioner's expertise (Elwyn et al., 2016, p. 254). The decision-making process entails joint consultation between the practitioner and the patient when making health care decisions (Hoffmann et al., 2017, p. 338), emphasising patient autonomy and self-determination (Lehane et al., 2023). Shared decision-making is an approach that involves the patients and practitioners reaching an agreement regarding the choice of treatment (Elwyn et al., 2016, p. 4). To implement EBP, it is recommended that practitioners follow an evidence-based process using the EBP steps (Dawes et al., 2005), which will be outlined in the next section.

1.2 The process of evidence-based practice: The five-step model

The process of EBP is, as referred to by Dawes et al. (2005), a five-step model, which includes: 1) Translating uncertainty to answerable questions (Ask), 2) retrieval of the best available evidence (Access), 3) critical appraisal of the evidence (Appraise), 4) applying of results in practice (Apply), and 5) evaluation of performance (Audit) (Table 1).

Table 1. Skills needed to perform the five EBP steps

EBP steps	Skills needed to perform the steps, which involve the ability to:
1. Ask	reflect on information needs and formulate a clinical question.
	identify relevant PICO*/PICo** elements.
2. Access	search for research evidence to inform decision-making in practice.
3. Apprais e	critically appraise research evidence, which can be guided by a critical appraisal checklist (i.e. from the Critical Appraisal Skills Program (CASP)).
4. Apply	integrate the research evidence with clinical experience and the patient's values in a given context.
5. Audit	describe how changes in practice were implemented and evaluated.
	evaluate the EBP process.

Table 1 is based on EBP literature (e.g. Dawes et al., 2005; Hoffmann et al., 2017; Polit & Beck, 2021)
* PICO (Abbreviation for Population, Intervention, Comparison, and Outcome) (Munn, Stern, et al., 2018)
** PICo (Abbreviation for Population, Interest, and Context) (Munn, Stern, et al., 2018)

Albarqouni et al. (2018) proposed that certain core competencies must be taught and acquired to learn EBP. Their study narrowed down the competencies by categorising them into the main steps of the EBP process, which are outlined in Table 1. Before starting the EBP process, the practitioner is required to reflect on the patients and all the aspects of their presentation, along with current practices, in order to identify any uncertainty of practice, often called Step 0 (Melnyk & Fineout-Overholt, 2023, p. 19). Efficient searching skills are required to find research evidence to answer clinical questions (Howard et al., 2022). This is particularly critical considering the increasing volume of research publications (Curcic, 2023; National Library of Medicine, 2023). It is also necessary to develop critical appraisal skills to evaluate the quality of the publications, including determining the research reliability, accuracy, and appropriateness for use in practice (Buccheri & Sharifi, 2017; Polit & Beck, 2021, p. 36). However, Tikkinen and Guyatt (2021) suggest prioritising the identification of critiqued and more highly synthesised evidence sources that include the risk of bias evaluation, as practitioners may lack the time and skills to perform critical appraisal of individual studies.

In addition to learning the mechanics of each EBP step, it is equally important to learn how to integrate them into practice (Straus et al., 2019, p. 267). Shared decision-making serves as one such way to support the integration of the EBP process into clinical practice (Hoffmann et al., 2017, p. 338). This is especially significant in the fourth step of the process (Table 1), where research evidence should be integrated with the patient's values and the practitioner's expertise (Elwyn et al., 2016, p. 254). To ensure the successful implementation of EBP, it is necessary to evaluate the process as a whole (Dawes et al., 2005). As part of this evaluation, self-assessment questions related to each EBP step can be relevant, such as “Am I asking clinically relevant questions?” and “Are my searches well executed?” (Straus et al., 2019, p. 224). Assessing changes to one’s practices can help identify potential barriers when it comes to translating evidence to practice and ways to overcome them (Albarqouni et al., 2018). This can be challenging given that research has shown that practitioners may lack EBP knowledge and thus have difficulties applying the evidence to the context at hand (Bellamy et al., 2006; Upton et al., 2014).

Frenk et al. (2010) proposed that the primary focus of higher education in the 21st century should be on transformative learning and educational interdependence. Transformative learning is one learning theory that promotes critical thinking – an essential clinical reasoning skill among health care professionals (Rojo et al., 2023). Transformative learning involves utilising previous experiences, critical reflection and questioning, and a willingness to challenge assumptions that are taken for granted (Merriam et al., 2007, p. 134; Taylor & Cranton, 2012). As such, transformative learning can support the ability to search, analyse, evaluate, and synthesise information to make informed decisions (Frenk et al., 2010); in other words, skills that practitioners need to make sound clinical choices and implement EBP.

Different modes of following the EBP process

According to Straus et al. (2019, p. 5), clinicians can integrate evidence into their practice using three modes: doing, using, and replicating. The “doing” mode involves following all the EBP steps. In a busy clinical setting, this can be time-consuming and challenging, with lack of time and resources reported as a common barrier to applying EBP (Paci et al., 2021; Sadeghi-Bazargani et al., 2014; Scurlock-Evans et al., 2014; Ubbink et al., 2013; Upton et al., 2014). The “using” mode requires less effort from the clinicians, as it involves conducting searches limited to evidence summaries that have already been critically appraised by others, eliminating the need for the third step – appraise. Nowadays, trustworthy pre-appraised evidence is increasingly available, which makes it easier for practitioners to implement evidence-based practices without being fully competent in critically appraising individual studies (Albarqouni et al., 2018). The “replicating” mode involves following the decisions of opinion leaders, thus eluding steps two and three – access and appraise (Straus et al., 2019, p. 5). However, this mode has a disadvantage as it involves following the advice of experts in the field without fully understanding if it is based on research evidence or the expert's opinion (Straus et al., 2019, p. 6). Regardless of the mode used, practitioners must integrate research evidence with the patient's values and circumstances (Straus et al., 2019, p. 5). Recent studies have shown that many students and graduates lack the necessary competencies to apply EBP in clinical practice (Daly & DeAngelis, 2017; Greenhalgh et al., 2014; Horntvedt et al., 2018). Thus, it seems necessary to strengthen the students' EBP skills before attempting to apply them in practice (Horntvedt et al., 2018).

1.3 Teaching and learning evidence-based practice

It has been recommended by Dawes et al. (2005) and Thomas et al. (2023) that EBP be integrated into and throughout the curricula for health care programmes, and not offered as stand-alone courses (Coomarasamy & Khan, 2004; Patelarou et al., 2020). The curriculum should be designed to support the learning of EBP knowledge, skills, attitudes, and behaviours (Thomas et al., 2023). According to Glasziou et al. (2008), learning EBP should be considered just as essential as other clinical competencies.

In 2006, a systematic review by Khan and Coomarasamy (2006) found that implementing interactive and clinically integrated teaching and learning activities was the most effective way of learning EBP. In 2014, an umbrella review (an overview of systematic reviews) of effective EBP teaching interventions was published by Young et al. (2014). The review concluded that teaching strategies that improved EBP learning were multifaceted, integrated into clinical practice, and included assessment of the learners. The umbrella review was updated in 2021 by Bala et al. (2021), and their findings confirmed the conclusions of both Young et al. (2014) and Khan and Coomarasamy (2006), in that the teaching should be interactive, multifaceted, integrated into clinical practice, and should include assessments.

Varied EBP learning strategies have been investigated in the literature, such as face-to-face, online, or blended learning, which may be delivered by way of journal clubs, teaching in clinical practice, lectures, or workshops (Bala et al., 2021; Rohwer et al., 2017). Multifaceted interventions include a combination of educational strategies, for example, a combination of journal clubs and tutorials (Bala et al., 2021). Interactive learning activities could, for example, be problem-based learning, sharing information, flipped classrooms, workshops, seminars with discussions, group work, and collaboration with librarians (Horntvedt et al., 2018; Larsen et al., 2019). Recently, interactive methods like gaming and simulation techniques and the use of mobile devices have been introduced (Kyriakoulis et al., 2016; Larsen et al., 2019; Rohwer et al., 2017). Nevertheless, a recent systematic review found that no single teaching modality was more effective than others in enhancing learner competency in EBP (Howard et al., 2022).

Integrating EBP learning into clinical contexts improves EBP skills, attitudes, and behaviours compared to traditional didactic methods (Bala et al., 2021; Coomarasamy & Khan, 2004) and further increase the relevance of EBP for students (Ryan, 2016). The EBP teaching should integrate various components, for example, through multifaceted methods, such as clinical skills, research evidence, and understanding the relevance of research results in terms of the patient (Lehane et al., 2023; Thomas et al., 2021). However, research has found that EBP teaching has not been sufficiently integrated into curricula (Bala et al., 2021) and that health and social care students face difficulties learning EBP, including lack of formal training in EBP and challenges in critically appraising the evidence (Fiset et al., 2017; Hlebš, 2022; Stronge & Cahill, 2012). Poor information literacy skills and limited knowledge of the EBP principles have also been identified as barriers to EBP among students (Horntvedt et al., 2018). In the qualitative systematic review conducted by Bradley et al. (2005), unclear descriptions of course objectives and content and the dissonance between the philosophy of EBP and the "art" of health care were also found to hinder EBP learning. Fiset et al. (2017) recommended that multifaceted interventions that combine different learning strategies be applied to address these barriers.

Albarqouni et al. (2018) identified 68 EBP core competencies for EBP teaching that can enhance EBP teaching and learning programmes. Teaching that is guided by these core competencies could better support the direction of the teaching. However, the list of competencies is not exhaustive, and educators must tailor them to the local learning needs and devote time to the content, discipline, and learners' prior experiences (Albarqouni et al., 2018). This aligns with the seminal work of Biggs (1996), who presented the concept of constructive alignment of teaching and learning. The content of this concept is based on the fact that there should be an alignment between the objectives of a course, the teaching and learning methods, and the assessment of the students (Biggs, 1996).

For educators to enhance the students' EBP learning, the educators themselves must have EBP competency. A systematic review of health care educators' EBP competencies found that educators generally possessed the necessary skills to integrate EBP into their teaching in the educational context but struggled with teaching the implementation of EBP in clinical care (Immonen et al., 2022). It has been suggested then that educators should take an integrated approach that spans both the classroom and clinical settings (Fiset et al., 2017). Educators must also ensure that future health and social care professionals have acquired EBP competencies

(Immonen et al., 2022). A systematic review of qualitative studies pointed out the importance of clearly communicating the aims and objectives of the teaching, especially when using innovative or complex teaching activities (Bradley et al., 2005). Educational strategies should involve and reflect on the learner's resources and preferences (Bala et al., 2021), which include timing, duration, content, delivery method, context, and prerequisites (Wakibi et al., 2021).

Albarqouni et al. (2018) emphasise that teaching alone is not enough and that the assessment of learning is important. Assessment was also highlighted by Bala et al. (2021) as essential for learning EBP. The objective of assessment can be either formative or summative (Tilson et al., 2011). Formative assessment is provided concurrently with the learning process, e.g. assessment for learning, while summative assessment is mainly provided at the end of a course or subject to establish the competence of qualification, e.g. assessment of learning (Mekonen & Fitiavana, 2021; Tilson et al., 2011). Different types of assessment are presented by Tilson et al. (2011) and range from the most simple, such as reaction to educational experience, to the most complex, such as benefit to patients. Reaction to educational experience, attitudes, and self-efficacy can be assessed using self-report or opinions. Knowledge should be assessed through cognitive testing and skills with performance assessment. Behaviours are proposed to be assessed with activity monitoring, and last, benefits to patients can be assessed using patient-oriented outcomes (Tilson et al., 2011). In the subsequent chapter, further insights into the use of assessment tools will be provided.

1.4 Assessment of evidence-based practice teaching and learning

It is essential to have instruments that map students' EBP competencies for evaluating EBP teaching approaches (Shaneyfelt et al., 2006). To encourage the widespread adoption of EBP in education, it is necessary to have valid and reliable measures of learning outcomes that are practical for educators and researchers to administer (Tilson et al., 2011). Using assessment tools when evaluating the outcomes of EBP teaching and learning can help educators track learners' progress and determine the effectiveness of their teaching methods (Albarqouni et al., 2018).

The Classification Rubric for EBP Assessment Tools in Education (CREATE) was developed in 2011 to help classify EBP assessment tools (Tilson et al., 2011). CREATE covers all five steps of the EBP process and different EBP assessment categories, such as benefits to patients, behaviours, skills, knowledge, self-efficacy, attitudes, and reactions to the educational experience (Tilson et al., 2011). CREATE also incorporates audience characteristics such as students or clinicians, EBP learners' aims, disciplines, and assessment aims. In this thesis, EBP skills have been particularly relevant. EBP skills in the CREATE framework are referred to as "the application of knowledge, ideally in a practical setting" (Tilson et al., 2011, p. 5). When assessing EBP skills, the learner must do an EBP task related to the five EBP steps (Table 1) (Tilson et al., 2011).

The first systematic review that evaluated instruments for teaching and learning EBP incorporated 115 articles, which included 104 instruments (Shaneyfelt et al., 2006). The review revealed that most of the included instruments evaluated EBP skills, mainly on acquiring and appraising evidence. In 2022, an umbrella review covering ten systematic reviews on EBP measures was published (Roberge-Dao et al., 2022). The review identified 204 unique measures, of which 27 were deemed adequate. Some assessment tools focused solely on one of the EBP steps, usually accessing evidence, while others covered many of the steps. Interestingly, only one tool covered all five EBP steps (Roberge-Dao et al., 2022).

Recent umbrella reviews conducted by Roberge-Dao et al. (2022) and Bala et al. (2021) revealed that some tools assessed a single domain, while others evaluated multiple domains. Two systematic reviews have shown that most EBP assessment tools focus mainly on evaluating skills, knowledge, and behaviour, with less attention given to attitudes (Kumaravel et al., 2020; Shaneyfelt et al., 2006). Other essential aspects, such as behaviours, reactions to EBP teaching, self-efficacy, and patient outcomes, were seldom assessed (Kumaravel et al., 2020). While assessing patient outcomes is necessary, it is challenging to isolate the impact of EBP on patient outcomes from other aspects of clinical practice (Kumaravel et al., 2020).

Assessment tools can include objective or self-reported measures, of which self-reported tools may contribute to biased results due to recall bias or social desirability responses (Roberge-Dao et al., 2022; Van de Mortel, 2008). It is therefore advisable to use objective tools for a true reflection of the situation (Buchanan et al., 2015; Shaneyfelt et al., 2006; Thomas et al., 2011). Despite this, self-report assessment tools are more commonly used, perhaps because objective assessment tools can be time-consuming to complete (Tilson et al., 2011). To address this issue, web-based documentation has been identified as an approach for education and evaluation purposes to objectively document EBP performance (Shaneyfelt et al., 2006; Thomas et al., 2023; Tilson et al., 2011), which can be achieved through the use of mobile apps.

1.5 Use of technology for learning and assessing evidence-based practice

In section 1.3, effective approaches to EBP teaching and learning were presented (Bala et al., 2021). The authors also proposed combining e-learning and face-to-face learning. A systematic review of e-learning to increase EBP competency by Rohwer et al. (2017) showed that e-learning – by itself or blended – improved EBP competency compared to no learning of EBP. However, there were no differences between e-learning and face-to-face learning. E-learning refers to teaching and learning delivered through digital technology either inside or outside the classroom (Rohwer et al., 2017). Digital learning technology can be delivered with the use of various media, such as podcasts, mobile apps, games, and videos (Ødegaard et al., 2021).

The use of mobile learning is increasingly common in higher education (Sung et al., 2016). With most students carrying smartphones, mobile learning is now a feasible educational method (Lall et al., 2019). Mobile devices can create an extensive learning environment and facilitate collaborative learning outside the classroom through providing access to information and learning resources (Chang & Hwang, 2018; Hwang et al., 2023; Kim & Park, 2019; Kumar & Mohite, 2018; Masters et al., 2016; Mi et al., 2016; Olivier et al., 2020). This, in turn, may have a positive impact on students' learning outcomes (Chen et al., 2021). The use of digital technology for learning aligns with active learning theory. One of the first articles on active learning was by Prince (2004), which showed that active, collaborative, cooperative, and problem-based learning supported the student's learning. In a recent article on the digital transformation of teaching in higher education by Røe et al. (2022), it was proposed that active digital learning pedagogy should be founded on a student-centered perspective, provide formative feedback, include constructive alignment, and the use of flexible infrastructure.

A systematic review of various educational strategies for teaching EBP found that mobile apps could be an effective strategy for undergraduate students (Kyriakoulis et al., 2016). However, limited research has been conducted on the effectiveness of mobile apps for teaching EBP (Larsen et al., 2019; Patelarou et al., 2020). Some studies have investigated the use of mobile apps for teaching EBP in health care education (Carlson, 2018; Lam et al., 2018; Long et al., 2016; Morris & Maynard, 2010) and medical education (Friederichs et al., 2014; Liu, 2014). Two of these studies found that students who used mobile devices to access EBP resources improved their EBP abilities, such as correctly applying the relevant PICO elements when using the EBR tool (Long et al., 2016), and improved EBP knowledge and skills, including appraisal of clinical guidelines (Morris & Maynard, 2010). In terms of an app developed by Carlson (2018), only a few students utilised the app even though it was perceived as helpful by those who used it.

It is worth noting, though, that while there are mobile apps that support the EBP process, they do not cover all steps of the process. For example, PubMed Mobile (UAB Library, 2023) only supports search and retrieval and is connected with the PubMed database, while BestEvidence (BestEvidence, 2023) connects to the Trip search engine with the aim of supporting the search, retrieval, and critical appraisal of research evidence.

Mobile devices also present challenges, such as small screen sizes and connectivity problems (Mi et al., 2016; Strandell-Laine et al., 2015). Nursing students have reported barriers to using mobile devices, such as low technology literacy and negative reactions from staff and patients (Lee et al., 2018; Strandell-Laine et al., 2015). A busy clinical setting, distractions from social media, and unclear policies related to the use of mobile devices have also been reported as possible barriers to using such devices in the workplace (Maudsley et al., 2018). Specifically for EBP apps, reported barriers that hindered the use of mobile devices during clinical placement included concerns about theft, internet connection problems, and small screen sizes (Morris & Maynard, 2010). Furthermore, students found it challenging to perform EBP outside the educational environment, as the process was vague and difficult (Lam et al., 2018).

Despite these challenges, a systematic review in physiotherapy indicates that if digital learning is carried out as blended or distance learning, it can be more effective than traditional teaching (Ødegaard et al., 2021). When introducing technology into teaching, it is important to consider and incorporate training in the use of the technology (Söderström & Olsen, 2013, p. 96). Properly planned strategies for integrating technology into curricula, including teacher facilitation, are needed (Lillejord et al., 2018). It is also necessary to apply relevant pedagogical principles for learning in higher education (Fossland, 2015, p. 229), such as transformative and active learning, to ensure that the technology is not perceived as a distraction from learning (Melnyk & Fineout-Overholt, 2019, p. 459). The most central success factors presented in a systematic review of mobile learning experiences were platform accessibility, internet access, personalisation of the platform, the possibility of blended learning, and the contribution of making learning enjoyable (Alrasheedi et al., 2015). Furthermore, as highlighted in the Digital European Action Plan, digital education and training depend on high-quality content and user-friendly tools (European Commission, 2023). Thus, the usefulness of educational apps is essential when incorporating mobile devices into the learning environment, making usability testing necessary (Kumar & Mohite, 2018).

1.6 Usability testing of mobile apps

Usability testing is important to determine the effectiveness, efficiency, usefulness, learnability, accessibility, and overall satisfaction of mobile apps (Rubin & Chisnell, 2008, p. 4). A usable app allows users to do what they intend to do the way they expect to, without encountering any hinderances, hesitations, or confusion (Rubin & Chisnell, 2008, p. 4). According to the International Organization for Standardization, ISO9241-11 (2018), usability can be defined as "the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use".

When conducting usability testing, the primary aim is to identify any difficulties in the app and make it easy and understandable for the end-user. Early and frequent testing with few participants is necessary to identify and resolve problems in the development (Rubin & Chisnell, 2008; Söderström & Olsen, 2013). Furthermore, it is important to involve end-users in the testing process, as developers may not realise or understand user's issues since they know how the system works (Söderström & Olsen, 2013, pp. 99-100). The Government Digital Service Design Principles in the United Kingdom propose starting with the users' needs and involving them early on and throughout the design process to ensure a successful digital project (Central Digital and Data Office, 2019). Indeed, if users find the system beneficial, providing relative advantage, they will use it spontaneously and enthusiastically (Greenhalgh, 2018, p. 146; Söderström & Olsen, 2013, p. 195). Although the goal is to make apps intuitive, some assistance may be required, but it should be brief, timely, and unavoidable (Krug, 2014, p. 47).

Usability methods

When using mobile apps for teaching and learning, it is necessary to evaluate their effectiveness by applying various usability methods and attributes (Zhang & Adipat, 2005). This helps us understand their purpose and functionality better. Several usability methods are described in the literature, which can be categorised into four types: inquiry, user testing, inspection, and analytical modelling (Weichbroth, 2020). Inquiry testing involves gathering data through questionnaires, interviews, or focus groups. User testing methods include, amongst others, think-aloud methods, performance measurements, and eye-tracking. Inspection methods involve experts testing the app, cognitive walk-throughs, and heuristic evaluations. Lastly, analytical modelling methods include cognitive task analysis and task environment analysis (Weichbroth, 2020). In the systematic review conducted by Weichbroth (2020), most studies applied inquiry methods using controlled observations and questionnaires by way of data collection methods.

Usability testing can be carried out in a laboratory or through field testing. However, laboratory testing is the most commonly used method (Kumar & Mohite, 2018; Nayebi et al., 2012). In a laboratory setting, testing is performed in a controlled environment, whereas field testing is done in a real-life setting. The latter allows for data collection in the environment where the app is intended to be used, making it more credible, albeit more challenging to control. On the other hand, laboratory testing provides a controlled environment, making it easier to manage, with the downside being that it may not capture everything that could happen in a real-life situation (Kumar & Mohite, 2018).

Usability attributes

Usability attributes are features used to measure the quality of a mobile app (Kumar & Mohite, 2018). In the definition of the ISO standard, three usability attributes are included: effectiveness, efficiency, and satisfaction (ISO9241-11, 2018). Nielsen (1994) identified five usability attributes: efficiency, satisfaction, learnability, memorability, and errors. In a recent systematic review by Weichbroth (2020) on the usability of mobile applications, 75 usability attributes were found, with efficiency, satisfaction, effectiveness, learnability, memorability, cognitive load, and errors as the most frequent ones. Since there are no standard recommendations and a wide variety of usability attributes, Zhang and Adipat (2005) recommend selecting appropriate attributes to evaluate the apps depending on the nature of the technology and the objective of the usability study. When conducting usability testing on mobile apps, defining the usability attributes to be examined is considered a best practice (Kumar & Mohite, 2018). Definitions of the most frequently used usability attributes are presented and explained in Table 2.

Table 2: Frequently applied usability attributes

Usability attributes	Explanation of content
Cognitive load	Cognitive load relates to the mental activity required of mobile app users. This revolves around the difficulties of the app's features, the number of elements in a task, and the amount of mental effort used to complete tasks in the app (Weichbroth, 2020).
Comprehensibility	Comprehensibility or readability is how easily users can understand the content on mobile devices (Kumar & Mohite, 2018).
Effectiveness	Effectiveness is the accuracy with which users complete tasks in a given context (ISO9241-11, 2018; Kumar & Mohite, 2018). This can be measured, for instance, by the number of completed tasks and the number of double taps or if the back button is used (Weichbroth, 2020).
Efficiency	Efficiency is how quickly users can accomplish a task using the mobile application (ISO9241-11, 2018; Kumar & Mohite, 2018; Nielsen, 1994). There are different ways to measure this, such as duration spent on each screen or requiring the user to complete a task and observing the user's error rate (Weichbroth, 2020).
Errors	Errors refer to mistakes made by users while using the mobile app (Kumar & Mohite, 2018; Nielsen, 1994). The error category relates to the need for the system to have a low error rate so that users make few mistakes when using the system, and if they do make errors, they must be able to quickly recover from them. This category also relates to the ability of the application itself to recover from errors that have occurred (Weichbroth, 2020).
Learnability	Learnability relates to the fact that the system should be easy to learn so that the user can rapidly get to work using the system. Learnability is how easily users can understand and improve performance (Kumar & Mohite, 2018; Nielsen, 1994) and is also concerned with the capacity of a user to achieve proficiency with an application over time (Weichbroth, 2020).
Learning performance	Learning performance measures the effectiveness of the users learning and how the mobile app facilitates learning (Kumar & Mohite, 2018; Zhang & Adipat, 2005).
Memorability	Memorability is how easy the system is to remember, so the user can return to it after some period of not having used it without having to re-learn everything. This refers to how easily users can recall how to use an application after discontinuing use for a certain period of time (Kumar & Mohite, 2018; Nielsen, 1994; Weichbroth, 2020).
Satisfaction	Satisfaction involves freedom from discomfort and having a positive attitude towards using the product. User satisfaction reflects users' attitudes around using mobile apps and their perceived level of fulfilment of expected needs (ISO9241-11, 2018; Kumar & Mohite, 2018; Nielsen, 1994; Weichbroth, 2020). This is also about whether the user will recommend the app to others (Brooke, 2013).
Simplicity	Simplicity is the degree to which users find ways to complete a task (Kumar & Mohite, 2018). This generally deals with how easy the app is to understand or whether the design is perceived as uncomplicated (Weichbroth, 2020).

1.7 The context of this thesis

This thesis (Papers I and II) was carried out at the Faculty of Health and Social Sciences (FHS) at the Western Norway University of Applied Sciences (HVL). FHS offers bachelor's degree programmes in nursing, occupational therapy, physiotherapy, radiography, child protection and child welfare, social education, and social work. In Norway, a bachelor's degree requires three years' of study and corresponds to 180 credits in the European Credit Transfer and Accumulation System (ECTS). Typically, 25 to 30 hours of study work is expected per ECTS (Norwegian Directorate for Higher Education and Skills, 2023).

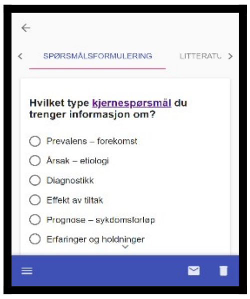
The regulations for the Norwegian national health and social care programmes legislate the incorporation of EBP into the curricula pertaining to the health and social care disciplines ("Forskrift om felles rammeplan for helse- og sosialfagutdanninger," 2017). According to this regulation, graduates must be able to acquire new knowledge and make professional assessments, decisions, and actions in line with EBP. Transformative learning was also recommended in the white paper, Quality Culture in Higher Education, as a way to facilitate students' ability to develop evidence-based and critical reflective thinking (Meld.St. 16 (2016-2017)). The use of digital technology is highlighted in this same paper, as a way to support transformative learning and provide opportunities for teaching and learning the content and organisation of the disciplines, including new communication methods (Meld.St. 16 (2016-2017), p. 12). To meet the expectations of the regulations and recommendations in the white paper, a mobile app was developed at HVL to support students' learning of EBP.

1.7.1 The *EBPsteps* mobile app

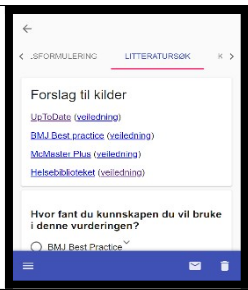
In 2015, the mobile web-based app *EBPsteps* was developed at HVL. When referring to the name of the app in this thesis, this will be presented in italics as *EBPsteps*. The app was designed to support health and social care students learning EBP. The app guides users through the steps of EBP, as outlined in Section 1.2, and can also be used to document the EBP processes. The prototype of the app investigated in this study was available and could be accessed through any device at the website http://www.ebpsteps.no (HVL, 2015). Table 3 provides a description of the app's content, alongside sample screenshots of the app.

Table 3. Content of the *EBPsteps* mobile app

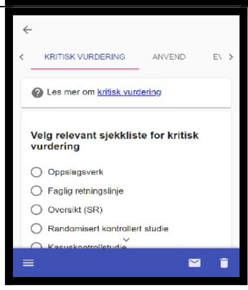
<table>
<tr><th>Content and activities in the EBPsteps</th><th>Sample screenshots</th></tr>
<tr><td>
1. Ask

Students are asked to:
• reflect on information needs.
• formulate a clinical question.
• identify the type of clinical questions from a drop-down menu (i.e. prevalence, cause, diagnostics, the effect of therapy, prognosis, or experiences).
• fill in the PICO*/PICo** elements.
</td><td>


</td></tr>
<tr><td>
2. Access

Students are asked to:
• report the information source used to identify research evidence.
• provide links (URL address) to the research evidence identified.
</td><td>


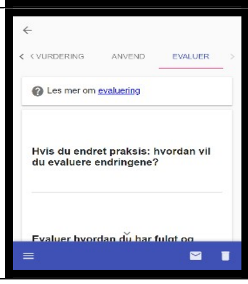
</td></tr>
<tr><td>
3. Appraise

Students are asked to:
• critically appraise the identified evidence using relevant critical appraisal checklist from a drop-down menu (from the following evidence sources: encyclopaedia chapters, guidelines, systematic reviews, randomised controlled trials (RCTs), qualitative, diagnostic, case-control, cohort, and prevalence studies).
</td><td>


</td></tr>
<tr><td>
4. Apply

Students are asked to:
• report how the research evidence they identified was applied.
• choose from a drop-down menu to report which shared decision-making approaches they applied in cooperation with the patient.
</td><td>


</td></tr>
<tr><td>
5. Audit

Students are asked to:
• report and describe if changes in practice were implemented and evaluated.
• evaluate the process of following the five EBP steps.
</td><td>


</td></tr>
</table>

* PICO (Abbreviation for Population, Intervention, Comparison, and Outcome).
** PICo (Abbreviation for Population, Interest, and Context).

The *EBPsteps* app connects to the Norwegian Electronic Health Library (Nylenna et al., 2010), which provides access to guidelines, systematic reviews, scientific journals, and other full-text resources (Helsebibilioteket [Health Library], 2023a). The app also links to EBP learning resources via the National Health Library (Helsebibilioteket [Health Library], 2023b). For each clinical question, users can report and save their EBP processes and create Portable Document Format (PDF) files that can be shared via email and used for evaluation and feedback from teachers and peers. The PDFs created in the app are thereafter referred to as Critically Appraised Topics (CATs). A CAT summarises research evidence on a clinical question (Callander et al., 2017) and includes information about all five EBP steps (Ask, Access, Appraise, Apply, and Audit). The *EBPsteps* is only available in Norwegian, although it would be desirable to offer it in other languages with customised linked resources.

2. Aims

The overall aim of this thesis was to enhance our knowledge of how health and social care students use a new and innovative mobile app learning evidence-based practice (EBP). In addition, the aim was to broaden our understanding of methods and attributes relevant to usability studies of mobile apps for health care education. Three research papers were completed to explore the overall aim of this thesis, and the specific objectives for these were:

Paper I: To explore health and social care students' experiences of learning about EBP using the mobile application *EBPsteps* during their clinical placements.

Paper II: To assess occupational therapy students' EBP skills as reported in a mobile app.

Paper III: To identify usability methods and attributes in usability studies of mobile apps for health care education by performing a scoping review.

3. Materials and methods

This chapter provides detailed information about the materials and methods used in this thesis. First, an overview of the study designs of the three papers will be given, followed by a description of the methodological choices made for each study (Papers I–III).

3.1 Study designs (Papers I–III)

To respond to the overall aim of this thesis, a multi-method approach was used. This approach involved conducting three research studies: A qualitative study (Paper I), a quantitative study (Paper II), and a scoping review study (Paper III). Table 4 presents an overview of the methodological details for this thesis's three papers.

Table 4. Overview of methodology (Papers I–III)

Paper	Aim	Design	Sample	Year of data collection	Data collection	Analysis
I	To explore health and social care students' experiences of learning about EBP using the mobile application *EBPsteps* during their clinical placements	Qualitative study: Interpretive Description	Students from social education, physiotherapy, and occupational therapy* (n=15)	2017	Focus groups (four)	Interpretive description and constant comparison analysis
II	To assess occupational therapy students' EBP skills as reported in a mobile app	Quantitative study: cross-sectional	Students from occupational therapy* (n=119)	2018–2021	Students' EBP skills reported in a mobile app	Descriptive statistics and chi-square test
III	To identify usability methods and attributes in usability studies of mobile apps for health care education	Scoping review: Arksey & O'Malley framework	Research studies from health care education (n=98)	2008–2022	Systematic literature search	Synthesising and interpreting the data and deductive analysis

*Occupational therapy students participating in study I and II were from different cohorts.

3.2 The qualitative study (Paper I)

Using an interpretive description approach (Thorne, 2016), the first study (Paper I) investigated undergraduate students' experiences of using the *EBPsteps* app during clinical placements. This research approach is particularly suitable for studying phenomena in applied disciplines such as nursing or teaching (Lomborg & Ankersen, 2010) and is especially relevant when the aim is to generate practical knowledge (Thorne, 2016, pp. 38–41; Thorne et al., 1997).

Sample

For this study, we used purposive sampling to select second and third-year students who were pursuing a bachelor's degree in social education (SE), occupational therapy (OT), and physiotherapy (PT) at HVL. Fifteen out of thirty-three students who used the app were recruited via email and agreed to participate in the focus groups. Each focus group was comprised of participants studying towards the same bachelor's degree, and the groups varied in size from two to six participants (see Table 5).

Table 5. Number of participants in the focus groups and EBP sessions they had received

Education	Social Education 1 (3rd year)	Occupational Therapy (3rd year)	Physiotherapy (2nd year)	Social Education 2 (2nd year)
Number of participants	4	3	2	6
EBP sessions*	12	24	37	12

*Each session lasted 45 minutes

The average age of the participants was 26, and they were predominantly female (n=14). Additional details about the participants can be found in Table 1 of Paper I.

Setting

The bachelor's degree programmes in SE, OT, and PT spanned over three years, and a presentation of the context is provided in section 1.7. All student groups received EBP training during their respective undergraduate degree programmes, as shown in Table 5. The SE programme had standalone EBP sessions, while the PT and OT programmes provided integrated training over three years.

During this study, the students were briefly introduced to the *EBPsteps* app and its features and were encouraged to use it during their clinical placements. However, no additional EBP educational support was provided, and none of the course assignments were related to the *EBPsteps* app.

Data collection

Focus groups were conducted with students from the same educational programme to encourage interaction between participants, and to explore different perspectives on using the *EBPsteps* app. We chose to use such homogeneous groups as students from different programmes had varying levels of exposure to EBP teaching before using the app. Moreover, including students who knew each other beforehand could facilitate conversation. The focus groups were held on campus and were digitally recorded. Participants were given a gift card valued at NOK 500 for their participation. The focus groups took place between February and May 2017 and lasted approximately 1.5 hours.

The semi-structured interview guide was developed to align with the aim of the study and previous research in the field of EBP teaching (e.g. Dawes et al., 2005; Young et al., 2014). The guide was further informed by usability attributes such as learnability, satisfaction, efficiency, memorability, errors, and navigation, as described by Kumar and Mohite (2018). The development of the guide was also influenced by literature on focus groups (Krueger & Casey, 2015; Stalmeijer et al., 2014). The interview questions were centered around the design of the app's functionality and technical aspects, as well as the users' experiences of learning EBP using the app during their clinical placements and the teaching and introduction to the app. The interview guide is available in Appendix S1 of Paper I and Appendix 1 of this thesis.

In the focus groups, three experienced EBP teachers acted as moderators and co-moderators. We made sure that the moderators did not have any teaching or assessment responsibilities for the students they interviewed, which, according to Stalmeijer et al. (2014), can positively affect the power and relationship between the moderator and the participants. One of the moderators also played a key role in initiating the app's development.

During the focus groups, some participants may have been hesitant to take an active part or might have been misunderstood. To address these issues, we e-mailed participants a summary of the discussion for any clarification, additions, or comments. This process, known as member-checking, can help ensure the accuracy of the information gathered during the focus groups (Krueger & Casey, 2015).

Data analysis

The analysis process for this study followed the four phases of the interpretive description approach: transcription, broad coding, comparing and contrasting, and developing themes and patterns (Thorne, 2016, pp. 155–197). In the first phase, the moderators transcribed the interviews after each focus group to get an idea of the content. In the second phase, the three moderators read through the transcripts to become familiar with the content and to start broad coding and organising within each focus group. To ensure a coherent interpretation, key verbatim segments from the transcripts were collected instead of using line-by-line coding, which is consistent with interpretive description (Thorne, 2016, pp. 163–164). In the third phase, the same three moderators coded the results across the different focus groups in relation to the research question using Microsoft Word (Microsoft Corporation, 2023b). Concurrently, the constant comparison analysis (Thorne, 2016, p. 168) began, looking for similar and different categories and possible themes within and across the focus groups. This involved comparing statements across different focus groups and educational programmes and grouping similar quotes to identify possible themes, as described by Thorne (2016, p. 168). An example of the analysis process is provided in Table 6.

During the fourth and final phase of the analysis process, the indication of possible patterns and themes evolved. We made sure to keep the grouping of the data as broad as possible to avoid premature closure, as recommended by Thorne (2016, p. 194). The patterns and themes were continuously reviewed until we reached a final decision on the interpretive themes. These four phases helped us to gain a comprehensive understanding of the similarities and differences across the different focus groups. The aim was to test and challenge our preliminary interpretations to achieve an ordered and coherent result, so as to gain a comprehensive understanding of the participants' experiences of the *EBPsteps* app.

Table 6. Illustration of the analysis process across interviews

Data from each focus groups	**Broad coding**	**Condensed coding across focus groups**
I was on placement in a nursery with a child with autism who demonstrated a lot of self-stimulation. The nursery staff used a weighted vest to calm the child. Then, I discussed the effect of a weighted vest on self-stimulation with my clinical instructor, and my instructor suggested that I search for research in that area. Consequently, I used the app (Stud.3, Social Education 1).	Learning needs related to intervention. The supervisor plays an important role.	Students across focus groups expressed a need for more knowledge about treatments or challenges they encountered during clinical placement.
I used it [*EBPsteps*] in relation to an exam, and I used it [*EBPsteps*] to find research concerning a daycare centre and people who are developmentally disabled (Stud.3, Occupational Therapy).	Used the app for an exam and a situation in clinical practice.	These students explained that the need for information motivated them to use the app.
We [me and my fellow student] talked to my clinical instructor about pelvic floor training, which is recommended for almost every woman in the postnatal period. However, she [my clinical instructor] had heard on a postgraduate course that this practice was not necessarily the best practice anymore, as many women struggle with tight pelvic floor muscles. So, I found this interesting and wanted to check the research on this, but I did not find an answer. Nevertheless, I did not spend much time on it – half an hour when I had time (Stud.2, Physical Therapy).	The supervisor challenges the student, and the student understands the relevance of searching for updated research evidence but was not able to find anything. However, they didn't have much time to spend either. Time as a barrier?	Supervisors play an essential role in asking students to find research evidence. Barriers to using the app: lack of time
I worked with visual support [for children with autism] and chose to use the app, hoping it would help me systematise it [the EBP work process]. However, I struggled for a long time with its use, to understand how to use it [*EBPsteps*] (Stud.2, Social Education 2).	Hoped the app would systemise the EBP process. However, realise their lack of EBP competence and struggled with using the app. Digital problems or lack of digital competence?	lack of EBP competence difficulties with the use of the app

3.3 The quantitative study (Paper II)

For Paper II, a cross-sectional design was chosen in order to assess the EBP skills of occupational therapy (OT) students reported in the *EBPsteps* mobile app. This specific design was selected given the fact that descriptive studies aim to observe, describe, and document situations in a natural context (Polit & Beck, 2021, p. 196)

Sample

From 2018 to 2021, 150 third-year OT students at HVL were invited to use the *EBPsteps* app and were thus eligible for inclusion in the study. In total, 119 students chose to use the app and participate in the study.

Setting

The OT education is a three-year bachelor's degree that comprises six semesters. More information about the context of the programme is presented in section 1.7. Table 2 in Paper II provides an overview of the 27 standalone EBP sessions the OT students received by their fifth semester. During the first year of study, the EBP teaching focused on the steps Ask and Access, while in the second year, the teaching included the steps Ask and Access as well as Appraise and Apply. All five steps, including the additional step Audit, were taught by the fifth semester. EBP was also integrated into other learning activities, such as Problem-Based Learning (PBL) group activities, written assignments, and exams, as recommended by the research (Coomarasamy & Khan, 2004; Patelarou et al., 2020).

In this study, the *EBPsteps* app was incorporated into EBP teaching during the fifth semester to teach students how to use it. Students were introduced to the app through a video presentation and were supervised by a teacher while exploring its features on campus. The students were encouraged to use the app on campus for four weeks and during their 11-week clinical placements. Students could use either the *EBPsteps* app or a Word document to conduct their mandatory assignment and for completing an appendix to add to their take home exam at the end of the semester.

Data collection

By reporting the EBP process in the app, students produced Critical Appraised Topics (CATs). These CATs, created in the fifth semester, were exported from the students' *EBPsteps* user accounts to Microsoft Excel® (Microsoft Corporation, 2023a). A scoring plan was developed, described in detail in Appendix 2 of Paper II and Appendix 2 of this thesis, in order to assess the students' EBP skills objectively. We used a back-and-forth process to familiarise ourselves with the scoring plan and assessment. First, two researchers individually assessed ten CATs as correctly or incorrectly completed for each EBP step. We then discussed our assessments and used them as the basis for the remaining CATs at each step.

The scoring plan included a description of the correct answers for each EBP step. Two researchers independently scored each CAT to ensure consistency, and disagreements were resolved through discussion. The Norwegian data, anonymised by the authors, is available via HVL Open (Johnson & Olsen, 2023).

Data analysis

Descriptive statistics were used to summarise the assessment of each student's EBP skills based on the completed CATs. This included frequencies and percentages for categorical variables (i.e. answers scored as correct/incorrect) and mean and range for continuous variables (i.e. number of CATs produced per student).

The chi-square test was used to analyse the associations between identifying PICO/PICo elements and finding research evidence. Since each student may have completed more than one CAT, clustering was also introduced in the data. We applied a cluster-weighted chi-square test, as described by Gregg et al. (2022), instead of the classic chi-square test, to account for potentially correlated observations within clusters. The statistical significance level was set at 5%. We used SPSS Statistics, version 28.0 (IBM Corporation, 2021), and R (The R Foundation, 2022) for the statistical analyses.

3.4 The scoping review (Paper III)

In Paper III, the aim was to identify the methods and attributes used in usability studies of mobile health care education apps. We conducted a thorough study using the framework developed by Arksey and O'Malley (2005), as well as the expanded description by Levac et al. (2010) and Khalil et al. (2016). To support transparency and reduce duplication of work (Tricco et al., 2018), we also published the study protocol (Johnson et al., 2020), which can be found in Appendix 3. The research questions that guided the scoping review were:

1. Which usability methods are used to evaluate the usability of mobile apps for health care education?
2. Which usability attributes are reported in the usability studies of mobile apps for health care education?

Identifying relevant studies

We searched ten databases covering health care, education, and technology to find research articles as part of the scoping review. The search strategy was developed with the help of a senior research librarian, and this was peer-reviewed by another senior librarian according to the Peer Review of Electronic Search Strategies (PRESS), as recommended by McGowan et al. (2016). Details of the search strategy for all ten databases can be found in Appendix 2 of Paper III. We also manually searched the reference lists of included articles, conducted a citation search in Google Scholar, and searched OpenGrey for grey literature. The search was performed without any language restrictions. Our thorough search strategy followed the recommendations of Arksey and O'Malley (2005).

Selecting studies

Three researchers worked in pairs to independently determine the eligibility of the records based on their titles and abstracts. This process was aided by Rayyan web-based management software program (Ouzzani et al., 2016). If a record was deemed eligible by one of the researchers, it was included for full-text screening. Two researchers independently examined the full-text reports, and any disagreements were resolved through discussion. To help this process, we used the EndNote X9 Clarivate reference management system (Clarivate, 2013).

Charting the data

The first author extracted the data using Microsoft Excel (Microsoft Corporation, 2023), and another researcher reviewed it. The data extraction sheet included information about the study (e.g. author, title, publication year), the population (e.g. health profession educational programmes), concepts (e.g. usability methods and attributes), and context (e.g. usability phase, educational setting). The complete data extraction sheet is presented in Appendix 3 of Paper III.

The first author used deductive analysis to interpret the usability attributes in the included studies. This involved analysing the data based on a preexisting coding frame (Polit & Beck, 2021, p. 535). Our coding frame was based on the definition of usability attributes from existing research (ISO9241-11, 2018; Kumar & Mohite, 2018; Nielsen, 1994; Weichbroth, 2020; Zhang & Adipat, 2005), which also is presented in section 1.6 of this thesis. The analysis of the usability attributes was reviewed and discussed by another author.

3.5 Ethical and legal issues (Papers I-III)

Papers I and II

The Norwegian Agency for Shared Services in Education and Research approved two studies, Papers I and II (ID no. 50425) (Appendix 4 and 5). Before the focus group discussions (Paper I), students were provided with written information about the study and were required to give written informed consent (see Appendix 6). When using *EBPsteps*, students had to approve the data provided in the app used for the second study (Paper II) and confirm participation. An alternative to the app was also offered to make participation in the study voluntary. All non-anonymised records for both studies were kept on a secure research server at HVL to protect confidentiality. Names and personal information were removed from transcripts and data to ensure participants' anonymity.

Paper III

Ethical approval or consent to participate was unnecessary for the third study (Paper III) as the data used in the scoping review was obtained from published articles and did not contain personal information. Nevertheless, ethical considerations were considered by thoroughly analysing the information from the included studies and ensuring its accuracy in accordance with the original research.

4. Summary of findings

This chapter summarises the findings from the three papers included in this thesis. The comprehensive results are presented in the published versions of Papers I and III, the submitted version of Paper II, and as appendices to this thesis.

4.1 Paper I

Experiences with using a mobile application for learning evidence-based practice in health and social care education: An interpretive descriptive study

This research study explored the experiences of 15 health and social care students when learning EBP during clinical placement using the mobile app *EBPsteps*. After analysing the data, three main themes were interpreted: triggers for EBP, barriers to EBP, and design matters. An overview of these themes, with subthemes and quotes from the focus groups is provided in Table 7. The triggers for EBP included the following subthemes: the need for information in patient situations, coursework requiring research evidence, and the expectation from clinical instructors that students utilise research evidence during clinical placement. Conversely, the students' barriers to EBP were a lack of EBP knowledge, no requirements for EBP, and clinical instructors who did not prioritise EBP. Interestingly, in this study, a two-way relationship was identified between these themes. Academic requirements or encouragement from clinical instructors triggered students to use the *EBPsteps*, while a lack of these factors hindered their use of the app.

The significance of app design was encountered in the theme, design matters, including how the app's design either facilitated or hindered applying EBP. The students found that the *EBPsteps* facilitated easy access to necessary EBP resources, and they found it helpful that the resources were collected in one place. They also appreciated how the app functioned as a digital notebook and provided a clear overview of the EBP steps. However, some students encountered obstacles while using the app, such as difficulties with navigation and unfamiliar icons. Furthermore, they also faced challenges using the app during clinical placements. Included in this theme were student recommendations to improve the app's user experience, such as more explicit explanations of the EBP steps and a video presentation to help users better understand how to use the app.

Table 7: Themes and subthemes with quotes from Paper I

Main themes	Subthemes	Quates from the focus groups
Triggers for EBP	Information needs	I was on placement in a nursery with children who demonstrated a lot of self-stimulation. The nursery staff used a weighted vest to calm children. Then, I discussed the effect of a weighted vest on self-stimulation with my clinical instructor, and my instructors suggested that I should search for research in that area. Consequently, I used the app (Stud.3, SE1).
	Academic requirements	I have to, because it [EBP] is a requirement in the take-home exam, and for the undergraduate dissertation and everything, and we must use it. So, I want to learn it. That is why I tried to use the app, because I want to understand it [EBP] (Stud.3, SE2).
	Encouragement from clinical instructors	During the clinical placement, I needed to learn more about a diagnosis and a specific challenge related to that diagnosis. I spoke with the clinical instructor, and she suggested that I spend some time investigating this topic. Then I needed to start searching. The app became relevant to use (Stud.1, SE1).
Barriers to EBP	Lack of EBP knowledge	It [low level of EBP knowledge] is reflected in our use of the app. When we do not know what is behind it, we cannot do it. We cannot use it [*EBPsteps*], when we do not know anything about it [EBP] (Stud.2, SE2).
	Lack of academic demands	I only used what I had found to discuss in the assignment. I did not bother to use it [*EBPsteps*] further. I was satisfied because I had what I needed (Stud.1, PT).
	Lack of emphasis on EBP in clinical placement	They did not ask about it [EBP] when I was on my clinical placement. The clinical instructors did not talk about it either (Stud.1, PT).
Design matters	Design triggers for use of the *EBPsteps*	I also like things to be systematic, and everything we need to work with EBP is in one place. It is very nice (Stud.2, PT). I agree. It is a good idea to have it all in one place so that you do not have to look through x numbers of folders on *itslearning* [digital learning management system]. Where was it again? It was very good. You did not have to browse the book from page to page (Stud.1, PT).
	Design barriers to use of the *EBPsteps*	I was not aware of the small three dots next to the dictionary (Stud.2, OT). Instead of having the three dots, is it possible to have a “letter”, a “pen”, and a “garbage bin” for example? (Stud.1, OT).

4.2 Paper II

Occupational therapy students' evidence-based practice skills as reported in a mobile app: A cross-sectional study

In the second study, we assessed occupational therapy students' EBP skills reported in the *EBPsteps* mobile app. Of the 150 eligible participants, 119 of the students (79%) agreed to participate. Students produced 240 Critically Appraised Topics (CATs) in the *EBPsteps* during the study period (2018–2021), with an average of two CATs produced by each student (range 1–7).

In these CATs, most students correctly reported the first three steps of the EBP process, including identifying information needs, searching for research evidence, and critically appraising the evidence. However, few effect estimates were reported among the CATs that included the critical appraisal of randomised controlled trials and systematic reviews. The correctly reported PICO/PICo elements in the CATs are presented in Table 8.

Table 8. Correctly reported PICO/PICo elements

PICO*/PICo**			
Population	Intervention/Interest	Comparison	Outcome/Context
78%	79%	18%	43%

* PICO (Abbreviation for Population, Intervention, Comparison, and Outcome)
** PICo (Abbreviation for Population, Interest, and Context)

Research evidence was reported identified in 81% (n=195) of the CATs. A positive association was found between reporting the Population and Intervention/Interest elements of the PICO/PICo and the identification of research evidence ($p<0.001$).

The application and evaluation of practice change were the least accurately reported EBP steps. In 40% (n=95) of the CATs, the application of research evidence in clinical practice was reported. In only 61% (n=58) of those, a clear description of how the research evidence was applied was provided. We did not find a clear description of how practice change was evaluated in any of the CATs. At this step, the most common responses were 'did not change practice' or 'not relevant'. Evaluating the EBP process was reported in 55% (n=131) of the CATs.

4.3 Paper III

Usability methods and attributes reported in usability studies of mobile apps for health care education: Scoping review

The third study involved identifying the usability methods and attributes of usability studies of mobile apps for health care education. We conducted a thorough search in ten databases and found a total of 34,369 records. An additional 2,796 records were found by citation and reference list searches. After screening the titles and abstracts, 626 full-text reports were screened. Finally, 98 studies from 88 articles were included in this scoping review. Most of the included articles were obtained from database searches and were mainly found through Medline (n=35) and Scopus (n=15). Additional articles were found in Cinahl (n=9), Engineering Village (n=7), Web of Science (n=7), ERIC (n=2), PsycINFO (n=2), and Embase (n=2). IEEE and ACM did not contribute any new articles. Nine articles were found through citations and reference searches. The studies were conducted in 22 countries and published between 2008 and 2021. For a complete overview of the characteristics of the included articles – such as study authors, population, research design, data collection methods, and usability attributes – please refer to Table 2 in Paper III.

The articles analysed in this study used two main methods for evaluating usability: inquiry-based methods (95%) and user testing methods (5%). Of the inquiry-based methods, 47% (n=46) used 1-group designs, while think-aloud methods were applied in all of the user testing methods. Field testing was most common compared to laboratory testing, utilised in 72% (n=71) of the articles. The primary data collection method was that of questionnaires, employed in 82% (n=80) of the studies. Only 19 studies used a psychometrically tested questionnaire, with about half of these utilising the System Usability Scale (SUS) (9%, n=9).

In total, seventeen usability attributes were identified in the included studies, with the most frequently utilised being: ‘satisfaction’ (84%), ‘usefulness’ (58%), and ‘ease of use’ (51%). The least frequent ones included: ‘comprehensibility’ (2%), ‘memorability’ (2%), and ‘simplicity’ (2%). For more information on the usability attributes and related reports, please see Table 3 in Paper III.

5. Discussion

5.1 Methodological considerations

This thesis comprises three papers that consist of a qualitative and a quantitative study and a scoping review. Methodological rigor needs to be assessed in order to establish trustworthiness and credibility of the research (Davis et al., 2009). Thus, this chapter will consider the quality of Papers I-III. A discussion of the overall design of this thesis will be presented first.

5.1.1 Overall design

In educational research, different research designs are essential for investigating complex issues (Johnson & Christensen, 2020, p. 32). This thesis used a multi-method approach including three research designs to provide relevant perspectives on the aim of this thesis, which was to enhance our knowledge of health and social care students' learning of EBP using a new and innovative mobile app. The aim was also to broaden our understanding of usability methods and attributes relevant to usability studies of mobile apps for health care education. In Paper I, a qualitative study using focus groups, explored students' experiences of using a mobile app to learn EBP. The use of focus groups during an app's early development stages allows developers to identify any usability issues before full-scale implementation (Rubin & Chisnell, 2008). In Paper II, a cross-sectional study design was applied to objectively assess the students' EBP skills, as reported in the mobile app. Results from these two studies (Papers I and II) provided directions for further development of the *EBPsteps* app and educational instruction in EBP. While Papers I and II were conducted to enhance our knowledge of health and social care students' learning of EBP using *EBPsteps*, Paper III was conducted to broaden our understanding of usability methods and attributes applied in usability studies of mobile apps for health care education. A scoping review design is relevant when the aim is to summarise and disseminate the breadth of research findings in an area (Munn, Peters, et al., 2018).

5.1.2 The qualitative study (Paper I)

Interpretive description, as developed by Thorne (2016), was utilised to explore students' experiences of learning about EBP using the mobile app *EBPsteps* while on their clinical placements. Thorne (2016, pp. 233–235) suggests four quality criteria to evaluate study credibility: epistemological integrity, representative credibility, analytic logic, and interpretive authority.

Epistemological integrity

To ensure credibility in research, it is important that the research question, the researcher(s) perspective, and data interpretations are coherent (Lomborg & Ankersen, 2010; Thorne, 2016, p. 233). To create a clear and coherent interpretive description, the similarities and differences between the studied phenomena should be presented, highlighting their commonalities and variations (Thorne et al., 2004). In Paper I, we used focus groups to investigate the experiences of health and social care students learning EBP while using the *EBPsteps* app during clinical placement. My perspective as a researcher is that the app should be used as a supplementary tool for learning EBP, and it should be practical, effective, and user-friendly, in line with the recommendations of Kumar and Mohite (2018). The results of our study provided valuable insights into students' experiences with the app. We used this knowledge to improve the app and EBP teaching, which aligns with the purpose of interpretive description. This approach aims to produce knowledge that can inform and be applied in practice (Thorne, 2016, p. 36; Thorne et al., 2004).

In Paper I, we provided contextual and background information about participants in Table 1, alongside a detailed explanation of our research approach. Constant comparative analysis was used to identify patterns in the data and group similar dimensions within and across the focus groups, as suggested by Thorne (2016, p. 168) and Krueger and Casey (2015, p. 157). We aimed to provide a comprehensive overview of how knowledge was obtained and to ensure transparency in the analysis process. We also related the results to previous research in the area in accordance with Thorne et al. (2004), who suggested that the credibility of findings depends on their presentation and contextualisation within the larger picture.

Representative credibility

Representative credibility is achieved when a study's theoretical claims and results are consistent with how the phenomenon was sampled (Thorne, 2016, p. 234). To investigate the experiences of using a mobile app, we invited a purposive sample of 33 health and social care bachelor's degree students who had used the app. From this group, 15 agreed to participate and were divided into four focus groups, with two, three, four, and six participants in each group. Conducting three to four focus groups can be sufficient for a study, according to Krueger and Casey (2015, p. 245). Stalmeijer et al. (2014) suggest that the optimal size of focus groups varies between six to ten participants, but three to four participants may also be adequate. Having too few participants can turn a focus group into a group interview, resulting in the moderator receiving more attention than the participants (Stalmeijer et al., 2014). In our study, a group interview may have occurred in the group with only two participants. However, these two participants actively participated in the discussions during the session, and their contribution was included in the study results, which supported our interpretations.

Using different participant categories can contribute to data triangulation, strengthen the credibility of research (Stalmeijer et al., 2014), and enable researchers to recognise knowledge beyond a single angle of vision (Thorne, 2016, p. 234). Data triangulation involves using multiple perspectives to understand the study topic (Stalmeijer et al., 2014). To ensure multiple perspectives in relation to the use of the *EBPsteps*, we recruited students from different bachelor's degree programmes, including occupational therapy (OT), physiotherapy (PT), and social education (SE). In this study, the participating students had different experiences with EBP teaching and the use of the *EBPsteps*. For example, the PT and OT students received integrated EBP training, whereas the SE students received standalone EBP sessions (as presented in Paper I and Section 3.2).

When conducting focus groups, it is often recommended to include participants who do not know each other so as to maintain anonymity, especially if the discussion involves sensitive information (Sim & Waterfield, 2019). The students who participated in this study did know each other beforehand due to the fact that the students studied at the same programme and university. They were asked about their experiences with an educational app, so the theme was not particularly sensitive. Additionally, it was helpful that all the participants were from the same bachelor's degree programmes, as this allowed them to discuss their teaching experiences and not focus on the differences between their courses.

Analytic logic

The qualitative research report is expected to reflect an analytic logic, making the researcher's reasoning visible through the interpretations and knowledge claims (Thorne, 2016, p. 233). The analysis process was designed to be open, broad, and circular in order to avoid premature closure, which Thorne (2016, p. 194) emphasises as a strength. The analysis began at the initial coding stage, which involved reflection and interpretation of the data meanings, in line with Miles et al. (2020, p. 63). Instead of coding line-by-line, text was collected to promote a coherent interpretation consistent with the interpretive description approach (Thorne, 2016, pp. 163–164). The interpretations were based on critical reflection and continued interpretive challenges to capture the analytic insights, as described by Thorne (2016, p. 171).

When presenting the research results, it is important to include quotes from participants to accurately reflect their perspectives (Krueger & Casey, 2015, p. 140), as detailed in Paper I and Section 3.2 of this thesis. However, it is necessary to note that quotes do not serve as results or proof of the results' trustworthiness (Malterud, 2012, p. 111). Careful consideration should be given to which quotes to include to validate the results. Keeping multiple quotes alongside the results during analysis helped us stay true to the participant's statements while choosing relevant quotes to support our interpretive description of the results, as exemplified in Table 6 of Section 3.2 of this thesis. It is essential to verify the analysis to avoid selective perception during analysis (Krueger & Casey, 2015, p. 140). Therefore, quotes were included to validate the interpretive description of the results and emphasise that they were grounded in the data.

Within analytic logic, it is also relevant not to misinterpret the frequency of different themes (Thorne, 2016, p. 233). Just because certain themes appear more frequently does not necessarily mean that they are more important than themes that occur less often (Thorne, 2016, p. 195). For example, even though only a few students mentioned that their limited knowledge of EBP was one reason they did not use the app extensively, it was still considered a significant finding. This is because similar findings have been found in previous research by Aglen (2016) and Ryan (2016), where students struggled to apply EBP due to their lack of confidence in their research engagement abilities.

Interpretive authority

Interpretive authority is about the researcher's interpretations being trustworthy and not mainly a result of the researcher's own assumptions and experiences (Thorne, 2016, p. 235). To ensure interpretive authority, it can be relevant to allow participants of the focus groups to verify the findings through member checks (Korstjens & Moser, 2018). In this study, the participants received a summary of the focus group discussions after the interviews, and they were given the opportunity to ask questions or provide comments in case anything was unclear. As suggested by Thorne (2016, p. 112), member checking can be used to test confirmability of the results. Some researchers advise sending the study's interpretations to the participants for comments. However, Thorne (2016, p. 112) does not recommend this, as the interpretations may not be directly linked to the participants' statements, and they may not recognise their own content or disagree with the interpretations. This is one such reason why it is advisable to allow participants to clarify or comment on the content of the summary without influencing the outcome of the study to ensure an unbiased interpretation (Malterud, 2017, p. 182).

In interpretive authority, it is necessary to consider any findings and themes that may contradict the conclusions drawn to ensure that the conclusions reached are accurate and that the analysis process is not biased toward specific results (Thorne, 2016, p. 195). To ensure the credibility of our research, we involved three authors throughout the research process – from planning the study to data collection and analysis – which enabled investigator triangulation. This approach helped to strengthen the research process and increase the credibility of the results (Korstjens & Moser, 2018). During the analysis process, it was essential to remain impartial and look for positive and negative accounts of experiences of using the *EBPsteps,* which enabled us to identify usability issues of the app.

5.1.3 The quantitative study (Paper II)

According to Wang and Cheng (2020, p. 65), "Cross-sectional studies are observational studies that analyze data from a population at a single point in time". This design is suitable when examining a phenomenon or the association between phenomena (Polit & Beck, 2021, p. 162) and is often used to describe the characteristics of a population (Wang & Cheng, 2020). Thus, a cross-sectional design was used to assess students' EBP skills, as reported in the *EBPsteps* app in Paper II. Johnson and Christensen (2020, p. 268) refer to validity as "the correctness or truthfulness of the inferences that are made from the results of the study". In the subsequent section, the internal and external validity of the quantitative study (Paper II) will be discussed.

Internal validity

In research, internal validity refers to the accuracy of the conclusions drawn from the data collected from the study participants (Rothman et al., 2008, p. 128). This section addresses internal validity related to selection bias, information bias, and confounding, in addition to the adequacy of the sample size. Bias is systematic error that affects the results of a study and undermines validity (Polit & Beck, 2021, p. 778).

Selection bias

Selection bias can occur when specific procedures or factors are chosen that influence participation in a study (Rothman, 2008, p. 134), that is, if some individuals are more likely to be included than others (Szklo & Nieto, 2014, p. 111). Selection bias can be introduced at different time points, including when participants are invited to the study and when people accept to participate. The latter is also known as non-response bias. In this study, all occupational therapy (OT) students from four cohorts (2018–2021) at HVL were invited to participate. Thus, all eligible students (n=150) had an equal opportunity to be included in the study.

Participating in the study required using the *EBPsteps* app. The students were given the choice to use the app voluntarily or not. If the students chose to use the app, they also agreed to participate in the study. Recruitment was explained in detail in Sections 3.3 and 3.5. Self-referral to a study can affect its validity, as it may be associated with the outcome (Rothman et al., 2008, p. 134). For instance, if only students interested in mobile apps agreed to participate in the study, they may be early adopters of digital technology. This could make it easier for them to use the app, but whether they would also achieve better results than students who declined to participate is unclear as the outcome of the study was EBP skills and not the use of the app. In this study, 79% of eligible students chose to participate and use the app.

Information bias

Inaccurate measurements can lead to information bias, affecting study outcomes (Lash, 2021, p. 425). There are different types of information bias, including recall bias and misclassification bias (Bankhead et al., 2023), which will be addressed in this section. The CATs that students completed in the *EBPsteps* app provided objective data on the students' EBP skills. Typically, EBP skills are evaluated with the use of subjective or recall descriptions through self-reported questionnaires (Roberge-Dao et al., 2022). The use of objective data in a study can help avoid recall bias (Lash, 2021, p. 429; Wang & Cheng, 2020). Thus, recall bias was most likely not a threat to internal validity in this study.

Misclassification bias can occur if measurement errors exist in the study variables (Rothman et al., 2008, p. 129). To assess the students' EBP skills in this study (Paper II), we developed a scoring plan (Appendix 2) through a back-and-forth procedure. This involved two researchers who independently assessed a subset of 10 CATs. Any ambiguities in the assessment criteria were discussed, and adjustments to the scoring plan were made. The process was upheld until a 100% agreement was reached on all responses in the app. Two researchers assessed the remaining CATs independently and solved disagreements through consensus. While using multiple observers is recommended to reduce information bias (Szklo & Nieto, 2014, p. 121), we cannot rule out that some responses might have been wrongly categorized as incorrect or correct. The direction is, however, difficult to determine. It could have been of interest to document initial agreement between raters with statistical analyses of inter-rater reliability using Cohen's kappa, although this was not performed.

Confounding

Confounding variables are contaminating factors that affect the association between the variables of interest (Polit & Beck, 2021, p. 155). Particularly with observational studies, confounding variables can be an issue. This study examined the association between the students' ability to complete PICO/PICo elements and the reported use of research evidence. Confounding factors may have influenced the observed association, but this was difficult to elucidate. For instance, students' prior EBP knowledge and supervisors' expectations that students would apply EBP during clinical placement might be associated with completing PICO/PICo and finding research, but information on this was unavailable. Thus, the interpretations of the results should be considered tentative (Polit & Beck, 2021, p. 199).

Sample size

Insufficient statistical power can lead to false negative conclusions, known as type II error (Rothman et al., 2008, p. 155). In our study, we examined 240 CATs. We observed a statistically significant group difference for the investigated hypotheses at the 5 % significance level, indicating a sufficient sample size to detect the observed difference as statistically significant.

External validity

External validity, also known as generalisability, pertains to how research findings observed in the study can be applied to other groups or settings (Polit & Beck, 2021, p. 157; Rothman et al., 2008, p. 128). Generalisability may be limited in our study, as the data was collected from students in the same educational institution and programmes, those studying occupational therapy at HVL. However, health and social care students in Norway follow the same national curriculum regarding expected EBP competence and knowledge upon graduation ("Forskrift om felles rammeplan for helse- og sosialfagutdanninger," 2017). Thus, the results may be relevant to other health and social students in Norway.

External validity also refers to the extent to which inferences from study participants can apply to similar persons, as well as the overall applicability of the study (Murad et al., 2018). In Paper II, we thoroughly described the scoring plan to provide support to researchers or teachers who would like to use the *EBPsteps* app to assess CATs in another study or setting. The data files, which include our assessment, were openly published through HVL Open (Johnson & Olsen, 2023). This information can aid researchers or teachers in performing a similar study or implementing the *EBPsteps* in teaching activities. Consequently, the results from Paper II may be applicable to other health and social care programmes.

5.1.4 The scoping review (Paper III)

A scoping review is recommended to identify available literature in a relatively new field and clarify concepts within the area of interest (Arksey & O'Malley, 2005; Munn, Peters, et al., 2018). The design involves "a process of summarizing a range of evidence to convey the breadth and depth of a field" (Levac et al., 2010). A well-conducted scoping review demonstrates procedural and methodological rigor (Davis et al., 2009).

A strength of this scoping review was that a protocol was published (Johnson et al., 2020) (Appendix 3). The review involved a comprehensive search of ten databases, including citation searching, screening reference lists of included studies and searching OpenGrey. The eligibility of title and abstract, as well as full-text screening, were determined independently by two researchers. One researcher charted the data to the data extraction sheet, which was checked by another researcher. The use of two researchers throughout the study selection and data extraction process ensured the retrieval of relevant articles and contributed to the accurate presentation of data from included articles in the scoping review, in line with methodology literature (Arksey & O'Malley, 2005; Khalil et al., 2016; Levac et al., 2010).

Identifying relevant studies

Our priority was to include as many relevant studies as possible in order to answer the review questions, opting for sensitivity rather than specificity, as recommended by Siddaway, Wood and Hedges (2019). Therefore, we applied a broad search strategy that resulted in a high number of references (36,171 records identified). We used specific search terms for health and social care education and mobile apps but excluded *usability*. The reason was that *usability* has various meanings and does not always relate to the development of apps. Furthermore, some potentially relevant articles did not use the term *usability.* Instead, related words and synonyms such as development, evaluation, and utilisation were used, which could have contributed to excluding those from the search.

According to the PRISMA-ScR framework, it is recommended that an electronic search strategy for at least one database is presented in a scoping review (Tricco et al., 2018). In Paper III, we provided the search string for all ten databases, allowing replication of the complete search. Our approach to this aligns with more recent literature that recommends providing the search strategy for all databases when reporting literature searches in systematic reviews (Rethlefsen et al., 2021).

The identified articles in the scoping review were chosen by searching databases and citation and reference lists. The included articles were sourced from eight databases, and no additional articles were found in IEEE or ACM databases. This means that searching these two databases was irrelevant to our scoping review. We also found nine articles through citation and reference list searches, even though we had thoroughly searched the databases. This emphasises the importance of employing a broad search strategy with the inclusion of different sources, meaning both databases and reference lists, to detect all relevant articles, as Arksey and O'Malley (2005) recommended.

Selecting studies

When performing scoping reviews, the researcher(s) can expect to discover a significant amount of records (Peters et al., 2015). Two review authors independently screened titles and abstracts to ensure a comprehensive screening of all records and to avoid missing relevant studies. Studies considered eligible by one of the review authors at the title and abstract level were exported to the EndNote X9 (Clarivate) reference management system (Clarivate, 2013) for full-text examination. During the full-text examination, eligibility was also independently assessed by two reviewers. Despite these efforts, some relevant records may have been overlooked due to the sheer volume of records. In retrospect, we should have considered using machine learning, as suggested by Page et al. (2021), to assist in identifying relevant records.

Charting the data

Levac et al. (2010) emphasise the necessity of analysing results beyond merely presenting them in a narrative form. In our study, we employed deductive analysis to categorise the usability attributes in the included articles. Prior literature on usability attribute definitions (presented in Section 1.6 of this thesis) was used for the deductive analysis and to categorise the attributes in the included studies. The categorisations were initially performed by one author and checked by a second author. Any disagreement was solved by discussion.

We found that several of the included studies used an unclear and imprecise conceptualisation of the usability attributes applied, not using the terminology from the usability literature. For instance, the words "likes and dislikes" and "recommend use to others" were often used instead of the more widely used and scientifically accurate terms, such as 'satisfaction', by studies that tested this attribute. Similar challenges were found in a scoping review evaluating the usability of blended learning programmes in health care education (Arora et al., 2021), indicating a common problem with the ambiguity of these terms, which should be considered in future usability studies.

5.2 Discussion of key findings

5.2.1 Students need triggers to use the *EBPsteps* app

Students' use of the *EBPsteps* app was affected by triggers to use the app, as they used the app when they were required to apply EBP in their assignments (Paper I). As such, the app was useful when they had to apply EBP to solve a task. According to the umbrella review conducted by Bala et al. (2021), EBP learning assessment has a positive impact on EBP behaviour. However, as pointed out by Raaheim (2013, p. 23), assignments can foster or inhibit students learning. If the assignment supports the student's autonomy, is clear and relevant, and enough time is given to complete the task, it can promote learning. Furthermore, to support learning through assignments, there should be an alignment between the course objective, teaching and learning, and student assessment, as suggested by Biggs (1996).

EBP assessment tools can help educators keep track of their students' progress and evaluate the effectiveness of their teaching methods (Albarqouni et al., 2018; Straus et al., 2019, p. 240). The assessment of the learning should evaluate both the process and the product (Thomas et al., 2011) with the use of objective assessment tools (Buchanan et al., 2015). Performance testing is recommended to assess EBP skills (Tilson et al., 2011), and web-based documentation of these skills has been emphasised (Shaneyfelt et al., 2006). In the second study (Paper II), students' EBP skills were objectively assessed through the data they reported in the *EBPsteps* app, which documented their process of following the EBP steps. Few web-based assessment tools are available for EBP, and *EBPsteps* provide a valuable contribution to the field.

According to the results from the first study (Paper I), students were more motivated to use the app when their clinical instructor encouraged them to apply EBP during their clinical placements. Conversely, when the clinical instructor did not expect or discuss EBP with the students, it hindered them from prioritising EBP and using the app. Systematic reviews have suggested that clinical instructors who serve as EBP role models are essential for inspiring students to use EBP in their clinical practice (Ramis et al., 2019; Thomas et al., 2011). If clinical instructors practice and expect EBP from their students, and if the students have exposure to

EBP in a real-world setting, it is more likely that EBP will guide their practice (Hitch & Nicola-Richmond, 2017; Lehane et al., 2018). However, research has found that clinical instructors may lack EBP competence (Olsen et al., 2013; Upton et al., 2014), which may be a reason why many of them do not require EBP from their students.

Research has shown that incorporating EBP during clinical placement through easy access to research and regular journal clubs helps students apply research evidence (Hitch & Nicola-Richmond, 2017; Young et al., 2014). As emphasised in a systematic review, participating in journal clubs can strengthen participants' reflexive discussions and improve their confidence in using research evidence in practice (Deenadayalan et al., 2008). Students reported that clinical instructors' encouragement to find research evidence motivated them to use the app (Paper I). Furthermore, if students are expected to discuss research results with their clinical instructors in a journal club, it might support the application of research evidence in practice.

If the technology, such as the *EBPsteps* app, is not adequately integrated with teaching, it may affect students' ability to use it effectively. This is consistent with the results of the first study (Paper I), where students reported that EBP was not a priority in practice and was often not requested in assignments. To effectively use mobile apps for learning, it is essential to connect the use of the technology with teaching and learning approaches. The Technological Pedagogical Content Knowledge (TPACK) framework provides a relevant perspective in this regard, emphasising the importance of integrating technological, pedagogical, and content knowledge while teaching (Schmidt et al., 2009). When the intention with the technology is to support the students' learning processes and not just for administrative purposes, teachers must consider both the content and choice of technology in relation to pedagogy (Fossland, 2015, p. 11). The teacher's epistemological stance and their belief in how knowledge is applied also influence how apps are used in teaching (Wang et al., 2021). In other words, the teacher's interest and ability are important for implementing and effectively using technology (Korseberg et al., 2022, p. 29).

Greenhalgh (2018, p. 139) argues that the use of technology is not as simple as "plug and play". Technology is part of the social world and must be integrated into the relevant context. This aligns with the findings of the first study (Paper I), where students reported difficulties in prioritising the use of the app during their placement. The culture and rules regarding mobile app usage affect its utilisation, which refers to the socio-technical aspects of its use (Greenhalgh, 2018, p. 139). One such factor can be negative reactions from professionals or patients on device use during clinical practice (Strandell-Laine et al., 2015). To assist students in learning EBP during practice with the aid of the *EBPsteps*, it will be important to include discussions with the clinical instructors on the appropriate use of the app. Instructors can advise students when and how to use mobile apps during clinical placements (Masters et al., 2016; Maudsley et al., 2018). Such guidance can help students balance the use of the app with other activities and support their learning transition.

5.2.2 Students lack the necessary skills to follow the EBP steps Apply and Audit

Most of the students who participated in the second study (Paper II) did not report how they applied the research evidence, and none of them evaluated practice change, indicating that they struggled to use EBP skills in real-life situations. These findings correspond with previous research that shows that many students and graduates lack the necessary competencies to apply EBP in clinical practice (Daly & DeAngelis, 2017; Horntvedt et al., 2018). Although students in the second study were taught how to use the *EBPsteps* and given a mandatory EBP assignment, it was not directly linked to clinical practice, as Bala et al. (2021) recommended. This may explain why the students struggled with the two final EBP steps. To facilitate EBP among students, it is suggested to integrate the curriculum with case reflections and discussions on how to apply research evidence in practice (Thomas et al., 2021). Making EBP assignments mandatory during the clinical placement and integrating the usage of the *EBPsteps* app with teaching at the campus may ensure that students apply EBP and master the two final steps of the EBP process.

We found that students in the second study (Paper II) were able to apply the appropriate critical appraisal checklist in 79% of the CATs. However, few students reported effect estimates when critically appraising RCTs and systematic reviews. One reason could be that the students had trouble understanding statistical results. Previous studies have reported that health care students lack confidence in interpreting statistical results (DeCleene Huber et al., 2015; Hlebš, 2022; Olsen et al., 2013). It is suggested that understanding effect estimates is necessary when applying EBP (Albarqouni et al., 2018). Students' difficulties while practicing critical appraisal may impact their ability to apply the research evidence.

However, Tikkinen and Guyatt (2021) have questioned the emphasis on critical appraisal as part of EBP teaching, as an increasing number of pre-appraised research evidence is available, making the time-consuming task of critical appraisal in practice redundant. To understand the research recommendations, it is important to have a basic understanding of the methods and credibility of their conduct (Tikkinen & Guyatt, 2021). In addition to understanding statistical results, it is equally important to devote more time to understanding research findings and how they can be applied in clinical practice. Therefore, the use and application of research evidence should be given priority in EBP teaching (Hitch & Nicola-Richmond, 2017; Thomas et al., 2021).

Many of the students in the second study (Paper II) were facing difficulties in applying and evaluating research. To help them better understand the context of EBP, providing more varied and interactive teaching that adheres to the recommendations from Bala et al. (2021) may be helpful. Furthermore, to help students develop the necessary EBP competence and tailor their application and evaluation of research evidence, the teaching could be guided by the core competencies identified by Albarqouni et al. (2018). Moreover, an improved alignment between the technology, such as the *EBPsteps*, the learning content, and pedagogy, as emphasised in the TPACK framework (Schmidt et al., 2009), could lead to a better alignment and understanding of how the students can use the *EBPsteps* and apply EBP principles.

5.2.3 Educational apps must be easy to use, but training is needed

Based on the findings from the first study (Paper I), students reported that the design features of the *EBPsteps* app were either helpful or hindering its usage. The students contributed with several suggestions to improve the app. For instance, they were not aware of all the functions available in the app, such as the vertical three dots linked to e-mail, edit button, dictionary, and calculator. They suggested using more familiar icons instead. A well-designed and user-friendly app can prevent it from being difficult to use (Kumar & Mohite, 2018). Therefore, developing a mobile app that is easy to use can potentially guide students in the learning process and make it more useful. A systematic review of mobile learning adoption shows that people are more likely to accept a system if it is perceived as easy to use and less complex (Kumar & Chand, 2019). Improved usability can contribute to better use and success in e-learning environments (Davids et al., 2014). Therefore, it is necessary to understand how practical, effective, and user-friendly mobile devices are when introducing them into the learning environment (Kumar & Mohite, 2018).

The first study indicated that students had a positive impression of the app's design but encountered some design features that hindered the use of the app (Paper I), as one student said: "I lacked information about how things work. Yes, it was assumed that we knew this from the start" (Stud.3, SE2) (Paper I). Most of the students who participated in this study were in their early twenties; thus, we assumed that the younger generation, commonly referred to as "digital natives" or the "Google generation", would be able to use the app without any training or introduction. The term "digital native" pertains to individuals born after 1980 who have been exposed to digital technology and mobile phones their entire lives (Reid et al., 2023). However, the technology always necessitates some form of training and cannot be utilised right away (Söderström & Olsen, 2013), and it is recommended to introduce students to the app's features and interfaces to help them understand how it works (Maudsley et al., 2018; Strandell-Laine et al., 2015). Therefore, before conducting the second study (Paper II), we changed the teaching approach to include training in using the app. In class, we introduced a video presentation of the app and a comprehensive practical introduction. In this study, 79% of eligible students chose to use the app.

Research conducted by Strandell-Laine et al. (2015) demonstrates that students' lack of confidence in technology and insufficient technology literacy pose significant barriers to the adoption of mobile devices. Developing technology literacy is crucial for students to acquire digital skills, such as the ability to search efficiently and critically evaluate information (Doyle et al., 2016; Reid et al., 2023). In the first study (Paper I), the students seemed to lack technology literacy as they reported difficulties navigating and using the *EBPsteps*, possibly because they only received a brief introduction to the app and its features. In the second study (Paper II), where students were given a more thorough introduction to the app, most students correctly reported the first steps of the EBP process (Ask, Access, and Appraise), but had difficulties with the two final steps (Apply and Audit).

Another important aspect related to the use of technology in teaching was presented in a recent qualitative study on digital learning practices among physiotherapy students (Ødegaard et al., 2023). It was found that students faced difficulties connecting their digital learning practices to the clinical workplace demands. This aligns with the results of the second study (Paper II), where it was found that students struggled to report the final two steps of the EBP process, which involves applying and evaluating the use of research evidence. Students may require more support to understand and utilise technology to overcome learning challenges. The teacher has an important role in supporting and facilitating the students' engagement in the learning process while using technology (Söderlund et al., 2022). Furthermore, when using technology as part of the learning process, the timing, duration, content, and prerequisites of EBP teaching should be taken into consideration (Wakibi et al., 2021).

When using a learning app, the student needs to understand what to report in an app. A systematic review has identified some success factors that enhance the learning processes with the use of technology (Lillejord et al., 2018, p. 32). The review emphasised the need for teachers to model how to use the app, integrate technology into the course and assessment, and provide technical and pedagogical support to students throughout the course. Therefore, teachers must communicate what is expected of the students when introducing *EBPsteps* to ensure that students understand that the app is a learning tool, not a substitute for active involvement in the learning process. Moreover, teachers should shift their teaching approach from content delivery to active involvement of the students (Børte et al., 2023). *EBPsteps* provide guidance on what to include at each step, but it may be necessary to revise and clarify these instructions. According to Krug (2014, p. 47), any assistance provided in an app should be brief, timely, and unavoidable.

5.2.4 Various usability methods are necessary to understand the usability of an app

In the scoping review (Paper III), the majority of the included studies applied inquiry-based methods (95%) and questionnaires as the primary data collection method (82%). While inquiry-based methods are useful for gathering subjective data on the users (Weichbroth, 2020), it is important to apply various usability methods at different stages in the development process to obtain a more comprehensive understanding of the challenges users may encounter when using the app (Rubin & Chisnell, 2008, pp. 16–21). These methods may include user-testing and inspection methods, such as think-aloud testing, performance measurements, or cognitive walk-throughs. Future usability studies should consider using a greater variety of usability methods to obtain diverse perspectives on the app's usability.

Studies included in the scoping review (Paper III) applied objective and subjective measures when collecting data. Subjective data were mainly collected through self-reported questionnaires, while objective data was collected through task completion rates. One of the included studies in the review, Davids et al. (2014), found a discrepancy between subjective and objective data. Despite the presence of severe usability issues in their study, the participants rated the usability of the app highly. This highlights the importance of using a combination of usability methods for data collection. By the use of different methods, we can better understand the relationship between technology, users, and context (Rubin & Chisnell, 2008, p. 16). In the first study (Paper I), we collected subjective data on students' experiences with the use of the *EBPsteps* through focus groups. While focus groups are beneficial for obtaining qualitative information, they are not ideal for assessing performance issues and actual behaviour (Rubin & Chisnell, 2008, p. 17). Therefore, we utilised a cross-sectional design in Paper II to collect objective data on the students' EBP skills from the *EBPsteps*. These two approaches helped us to gain valuable insights and different perspectives on the usability of the *EBPsteps* app.

It is advisable to use a psychometrically tested usability questionnaire when collecting data through a questionnaire (Sousa & Lopez, 2017). However, only 19 out of 83 studies that used a questionnaire in our scoping review (Paper III) followed this recommendation. There could be several reasons why researchers avoid using a psychometrically tested questionnaire. One reason could be that existing psychometrically tested questionnaires, such as the System Usability Scale (SUS) and After-Scenario questionnaires, cover only a limited range of usability attributes, with learnability, efficiency, and satisfaction being the most common ones, as described by Sousa and Lopez (2017). Another reason could be that not all questionnaires are available in the language used by the researcher. The SUS questionnaire, one of the most commonly used usability questionnaire, has been translated into languages other than English, but these versions have not been validated (Brooke, 2013). Nevertheless, SUS is easy to understand, and despite some language issues, it has strong reliability (Sure, 2014). Therefore, to advance the field of usability science, it is recommended to use a psychometrically tested questionnaire when performing usability testing, in accordance with a systematic review of usability questionnaires (Sousa & Lopez, 2017).

5.2.5 Researchers must select appropriate and relevant usability attributes

Usability attributes are the features used to measure the quality of mobile apps (Kumar & Mohite, 2018). Several usability attributes are relevant, but satisfaction, efficiency, and effectiveness are frequently examined (Harrison et al., 2013; Weichbroth, 2020). Our review found that efficiency and effectiveness were not extensively studied in health care education apps, while satisfaction, usefulness, and ease of use were the most commonly identified usability attributes. Our findings are consistent with previous reviews on the usability of mobile learning apps (Kumar & Mohite, 2018), perhaps because these three attributes are the most pertinent when assessing mobile learning apps. However, with the lack of standard recommendations and a plethora of usability attributes, the choice of attribute depends on the technology and the objective of the study (Zhang & Adipat, 2005). Therefore, selecting appropriate usability attributes is essential when conducting a usability study (Kumar & Mohite, 2018).

One advantage of using apps for learning is that it is controlled by the learners' pace and time (Alrasheedi et al., 2015). However, apps can also be a source of distractions for users, as pointed out by Harrison et al. (2013). Therefore, it is important to consider the cognitive load when evaluating the usability of mobile learning apps. In Paper III, only a limited number of studies (3%) investigated this attribute. During clinical placement, students may encounter various distractions while using mobile apps. It is possible that cognitive load or fatigue from using the app was a factor contributing to why most students in the second study (Paper II) did not report the two final steps in the *EBPsteps* app.

6. Conclusion and implications

This study has enhanced our knowledge of how health and social care students use *EBPsteps* for learning EBP. We found that students used the *EBPsteps* app when required, either in EBP assignments or during clinical placement (Paper I). The lack of EBP knowledge and design features of the app hindered its use. We also found that students struggled to report the EBP steps Apply and Audit while using *EBPsteps* (Paper II). The reason behind this could be a lack of EBP competence, low technology literacy, design features of the app, or cognitive load. Knowledge of triggers and barriers towards using the *EBPsteps* app and which EBP steps students found most challenging gives directions for further development of the *EBPsteps* and EBP teaching.

This thesis has broadened our understanding of methods and attributes relevant to usability studies of mobile apps for health care education. It is essential to use various methods to gain a comprehensive understanding of the usability of learning apps. The studies included in the scoping review (Paper III) mainly used inquiry methods. However, relying on a limited range of usability methods can restrict our understanding of an educational app. Therefore, applying objective and subjective usability methods is necessary. To evaluate the usability of an app effectively, it is also important to choose appropriate usability attributes. The most used attributes for health care educational apps were satisfaction, usefulness, and ease of use. Selecting a wider variety of usability attributes before conducting a study can provide a more thorough understanding of the app's usability.

7. Future research

An updated native version of the app is now available for free on mobile phones (HVL, 2015). Native apps are only available through mobile phones, while non-native apps can run on multiple platforms (Galatioto, 2023). In a study on research use in practice, participants were asked to use either a mobile app or a computer to search for research evidence (Friederichs et al., 2014). The results showed that the participants preferred using computers over mobile apps when they performed the searches. Therefore, further research is required to investigate the consequences of not providing *EBPsteps* through computers.

Bala et al. (2021) and Howard et al. (2022) suggest that future studies should use validated assessment tools to evaluate the effectiveness of e-learning. Research has proposed using web-based documentation to evaluate EBP performance (Shaneyfelt et al., 2006; Thomas et al., 2023; Tilson et al., 2011). The scoring plan we developed to assess students' EBP skills in the cross-sectional study (Paper II) was thorough, but it needs further refinement and validation. In future studies this can be achieved by examining measurement properties like the COSMIN reliability and validity domains (Polit & Beck, 2021, p. 314).

There could be several reasons why students faced difficulties while using the app, such as the design of the app being too difficult, unclear reporting instructions in the app, student's lack of EBP competence, or other competing demands (Paper I). Additionally, unclear expectations from the teacher might have contributed to students' not completing the steps. Our studies (Papers I and II) could not rule out any of these reasons, and we need more usability testing to understand them better. Usability testing can provide more answers and explain how technology can become a successful and integrated part of teaching.

There are still unanswered questions about how students use the *EBPsteps*. The third study of this thesis (Paper III) recommends using objective and subjective usability methods and choosing relevant attributes to examine in a usability study. In our second study (Paper II), we found that the students seldom reported the two final steps of the EBP process (Apply and Audit). To better understand why, future research should conduct cognitive interview studies, such as think-aloud methods and other pilot studies with different populations, to further evaluate the app's usability.

Involving end-users in usability testing is crucial to ensure the success of a digital project, as emphasized by Central Digital and Data Office (2019). The *EBPsteps* app was specifically designed for health and social care students. Therefore, we explored students' experiences with the use of the app (Paper I), and we objectively assessed what the students reported in the app (Paper II). However, we did not explore the use of the app from a teacher's perspective. For *EBPsteps* to be effectively utilised in the teaching environment, teachers must include it in their teaching practices, and therefore, their involvement in future studies are essential. Future research should examine how teachers implement the use of *EBPsteps* in their teaching practices and they should be involved in the study design.

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PLOS ONE

RESEARCH ARTICLE

Experiences with using a mobile application for learning evidence-based practice in health and social care education: An interpretive descriptive study

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Abstract

Background

Health and social care students are expected to apply evidence-based practice (EBP). An innovative mobile application, *EBPsteps*, was developed to support learning EBP.

Aim

The aim of this study was to explore health and social care students' experiences of learning about EBP using the mobile application *EBPsteps* during their clinical placements.

Methods

An interpretive description approach guided the exploration of student experiences. Four focus groups were conducted with a convenience sample of students from three undergraduate degree programs: occupational therapy, physical therapy, and social education. The constant comparison method was used to categorize and compare the qualitative data.

Results

Three integrated themes were generated: "triggers for EBP", "barriers to EBP", and "design matters". Information needs, academic requirements, and encouragement from clinical instructors triggered the students to use *EBPsteps*. Lack of EBP knowledge, lack of academic demand, and lack of emphasis on EBP in clinical placement were barriers to using *EBPsteps*. Design issues mattered, as use of the app was motivated by design features such as the opportunity to practice EBP in one place and taking notes in a digital notebook. The use of the app was hindered by anticipation that the use of phones during clinical

ethical restriction on publicly sharing our data. In line with recommendations given by the Norwegian Centre for Research Data (project no. 50425), data are stored on a secure server at Western Norway University of Applied Sciences (HVL). The Research Integrity Officer at HVL, Anne-Mette Somby (Anne-Mette.Somby@hvl.no), may be contacted if queries regarding verifiability of data.

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placements would be viewed negatively by others and by specific design features, such as unfamiliar icons.

Conclusions

The students perceived the *EBPsteps* app as a relevant tool for learning EBP, although they also suggested specific changes to the design of the app. Requirements must be embedded in the curriculum to ensure that the app is used. Our findings bring important information to developing and implementing mobile applications as a teaching method in health and social care educations.

Introduction

Our society's welfare depends on health care practitioners' abilities to adapt to changes in clinical practice [1]. Transformative learning is one learning theory that can support the need to adapt, as its purpose is to produce informed change agents [2]. Transformative learning entails using previous experiences, utilizing critical reflection and questioning, and a willingness to change taken-for-granted assumptions [3, 4]. As such, transformative learning can promote the ability to search, analyze, assess, and synthesize information for decision making [2]. These are skills that health care practitioners need to make informed clinical choices and to practice evidence based. Evidence-based practice (EBP) is an approach that requires the use of the best available evidence from research and integrate it with clinical expertise, patient values, and specific circumstances to make clinical decisions [5, 6].

Health and social care educational programs have commonly incorporated EBP into their curriculum [7, 8]. However, healthcare students have reported critical barriers to apply EBP, such as lack of support from clinical instructors, lack of time, and difficulties in finding research evidence [9–11], and struggling to understand the relevance of EBP [12]. These barriers must be considered when planning for EBP teaching.

Young et al. [13] found that the best teaching strategies for improving EBP were multi-faceted, clinically integrated, interactive, and included learner' assessments. EBP teaching is most effective when integrated across curricula, as opposed to stand-alone courses [5, 13]. Teaching EBP to students increases their EBP knowledge and skills [13], although there are still questions to be answered regarding how to most effectively teach EBP [14].

Literature review

The use of technology within EBP teaching has increased and has proven to be an effective strategy among undergraduates [15]. A systematic review found that E-learning combined with face-to-face learning improved students' EBP knowledge and skills [14]. Four studies have utilized mobile applications (apps) for EBP teaching among healthcare students [16–19], and two studies among medical students [20, 21]. Three of these studies showed that students who used a mobile device to access EBP resources improved their EBP abilities [18–20]. Carlsen [16] emphasized that few students used their app, even though it was perceived as helpful by those who did. Students who utilized EBP apps during clinical placement reported barriers to use such as concerns about theft, problems with internet connection, and small screen sizes [18]. Students also emphasized EBP as vague and difficult to perform outside the educational environment [17]. A few mobile apps have been developed that support the EBP process. One example is the PubMed Mobile [22], which connects with the PubMed database and supports only search and retrieval. Another example is the BestEvidence [23], which connects to the Trip search engine and supports search, retrieval, and critical appraisal. However, these apps do not support all steps of the EBP process.

Mobile devices, such as phones and personal digital assistants, are now commonly used in higher education [24]. Systematic reviews have found that mobile devices provide extendable learning environments and access to a wide range of information and learning resources, and they can motivate adaptive and collaborative learning outside the classroom [25–29]. However, utility and features such as small screen size and connectivity problems may pose difficulties when using mobile devices for learning [26, 30]. Nursing students described that low technology literacy and negative reactions from staff and patients with regard to students' use of the device were barriers to using mobile devices [30, 31]. Another systematic review revealed that busy clinical settings, distractions by social connectivity, and unclear policies regarding the use of mobile devices on the clinical unit could also affect the devices' impact [32].

Two systematic reviews emphasized that the success of implementing mobile devices and apps in learning environments depends on the perceived usefulness of the app [25] and well-planned strategies integrated into curricula facilitated by faculty [33]. In order to determine what makes a mobile app usable, it is necessary to examine if the app is considered to be useful, efficient, effective, satisfying, learnable, and accessible [34].

Development of a mobile application to support learning EBP

An innovative mobile app, *EBPsteps*, was developed at the Western Norway University of Applied Sciences (HVL) to support the learning of EBP among health and social care students as a supplement to other EBP teaching methods (Fig 1).

EBPsteps was launched in 2015. Student representatives and faculties from various professions, including physiotherapy, nursing, occupational therapy, social education, and engineering, were involved in its development. The *EBPsteps* app guides users through all the five EBP steps that involve: 1) identifying information needs and formulating answerable questions; 2) finding the best evidence to answer the questions; 3) critically appraising the evidence; 4) applying the results to clinical practice; and 5) evaluating performance [5, 13]. As such, this five-step model assists students' EBP learning process. The app links to the Norwegian Electronic Health Library [35, 36], which includes learning resources for EBP, and access to guidelines, systematic reviews, scientific journals, and a wide variety of other full-text resources. The

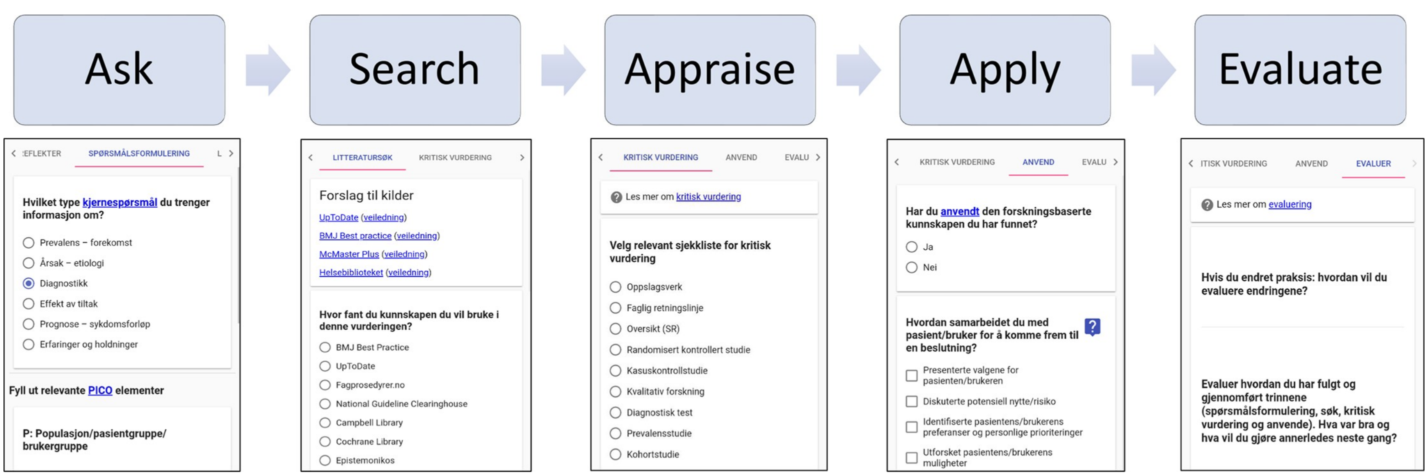

Fig 1. Sample screen of the *EBPsteps* application.

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EBPsteps app allows users to document and save processes related to each EBP step. All information stored in *EBPsteps* can be shared via e-mail, allowing for assessment and feedback from teachers and peers. The app is freely available and can be accessed via any device through the website http://www.ebpsteps.no [37]. While this app is currently only available in Norwegian, we believe that the lessons learned from this study apply to the development of other educational apps. Furthermore, it is planned that *EBPsteps* will be available in other languages with customization of linked resources.

Although technology can facilitate EBP teaching, further research is recommended on how technology can be used to enhance the learning process [15]. The aim of this study was to explore health and social care students' experiences of learning about EBP using the mobile application *EBPsteps* during their clinical placements.

Materials and methods

Design and sample

An interpretive description approach guided the process of exploring undergraduate students' experiences related to using the *EBPsteps* app during clinical placements. Interpretive description is regarded as a suitable research strategy to study phenomena in applied disciplines, such as nursing, education, or management [38]. The use of this strategy is relevant when the research aims to generate practical knowledge [39, 40]. The Consolidated criteria for reporting qualitative research (COREQ) checklist were followed to ensure transparent reporting of this study [41].

We introduced the app and its functions to four cohorts of Norwegian undergraduate students: third-year social education (SE) students ($n = 68$) (SE1), third-year occupational therapy (OT) students ($n = 26$), third-year physiotherapy (PT) students ($n = 66$), and second-year SE students ($n = 64$) (SE2) (Table 1).

A member of the research team briefly introduced the app and its functions to the students. Students were encouraged to use the app during their next clinical placements. No further educational support was offered, and there was no assessment or requirements related to the use of *EBPsteps*.

Table 1. Characteristics of participants.

Characteristics	Social Education 1 (3rd year)	Occupational Therapy (3rd year)	Physical Therapy (2nd year)	Social Education 2 (2nd year)
Number of students in the cohort	68	26	66	64
Students invited/participated	10/4	6/3	5/2	12/6
Gender				
Male	1			
Female	3	3	2	6
Age				
20–29	4	3	1	3
30–39			1	3
Clinical placement				
Specialist health service		2		
Primary care/schools	4	1	2	6
EBP teaching sessions*	12	24	37	12

*Teaching sessions, each lasted 45 minutes

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Via e-mail, we purposefully recruited participants among the thirty-three students who chose to use the app during clinical placements: ten SE1 students, six OT students, five PT students, and twelve SE2 students. In total, fifteen students, with a mean age of 26, agreed to participate in focus group interviews: four SE1 students, three OT students, two PT students, and six SE2 students. Most participants were female (n = 14), and most had completed clinical placements in primary care settings (n = 13). All student cohorts had received EBP training in their respective undergraduate programs. Timetables showed that PT students had received a higher number of EBP training sessions (37 sessions) than the other cohorts. SE students received the lowest number of EBP training sessions (12 sessions). In addition, SE students had received stand-alone sessions, whereas the EBP training was integrated across the three-year curricula in the PT and OT programs.

Data collection

In line with Krueger and Casey [42], focus groups were used to encourage interaction between participants to explore the different perspectives of using the *EBPsteps* app. Each focus group consisted of students from the same undergraduate degree program. All focus groups took place in meeting rooms at the campus, near the students' teaching environment. Participants received a gift card of 500 NOK (50 EUR) for participating in the study. The interview sessions were conducted between February and May 2017, lasted approximately 1.5 hours, and were digitally recorded.

We used a semi-structured interview guide that reflected the aim of the study and previous research within the field of EBP teaching. Literature inspired the development of the interview guide [5, 13, 42, 43], and it also covered themes on usability attributes, such as ease of use, satisfaction, efficiency, and usefulness [25]. The interview guide is attached as a S1 Appendix. Focus group interviews were led by moderators and co-moderators, who were all experienced EBP teachers. One of the moderators (NRO) initiated the development of the app. The moderators and co-moderators were not involved in teaching or assessment of the students they interviewed. In focus groups, there is a risk that some participants may take a passive role in the discussion or be misunderstood [42]. Therefore, a summary of the main feedback and issues brought up during the interviews was e-mailed to participants for clarification, additions, or comments (member-checking).

Data analysis

The interpretive description approach guided the analysis process and consisted of the following four phases: transcription, broad coding, comparing and contrasting, and developing themes and patterns [39]. In the first phase, the moderator transcribed the interviews. In the second phase, the three moderators (SGJ, KBT, NRO) read all the transcripts thoroughly, became familiar with the interviews' content, and started broad coding and organizing within each focus group. Microsoft Word [44] was used to support the analysis and manage the results to find similarities and differences across focus groups. To stimulate a coherent interpretation consistent with the interpretive description approach [39], the transcripts' key verbatim segments were collected, rather than coding line-by-line. In the third phase, the same three authors coded and organized the results across the different focus groups related to the research question. Concurrently, the constant comparison analysis [39] commenced, looking for similar and different categories and possible themes within and across interviews. The grouping of the data was as broad as possible to avoid premature closure, as described by Thorne [39]. In the fourth phase, an indication of patterns and themes arose, and these were revised several times until a final decision on the interpretive themes was made. The themes were presented to the other authors for comment and clarification. These four phases enabled us to gain a comprehensive insight and helped us to consider similarities and differences across the different focus groups. By testing and challenging preliminary interpretations, we aimed to achieve an ordered and coherent result.

Ethical considerations

The Norwegian Centre for Research Data approved the study (project no. 50425). We obtained written informed consent prior to all interviews. The consent forms, transcripts, and recordings were stored on the research server at the University College to preserve confidentiality. We preserved participants' anonymity by eliminating names and any personal information from transcripts to ensure that participants were not recognizable in the presentation of findings. The transcripts were only available to the three moderators/co-moderators (SGJ, KBT, NRO). The recordings will be deleted upon publication.

Results

Three integrated themes were generated from the analyses: "triggers for EBP", "barriers to EBP", and "design matters". Students reported that information needs, academic requirements, or encouragement from clinical instructors triggered the use of the *EBPsteps* app. Barriers to use *EBPsteps* included lack of EBP knowledge, lack of academic requirements related to course work, or lack of priority given to EBP during clinical placement. A two-way relationship was found between "triggers for EBP" and "barriers to EBP" (e.g., coursework requirements were both a trigger and a barrier). Students who were required to use EBP were motivated to use the app to learn EBP, whereas students who lacked such coursework requirements reported that this hindered them from using the app.

Similarly, clinical instructors who expected students to apply EBP triggered the use of the app, and students without such expectations did not consider using the app. A one-way interrelationship was found from "design matters" to "triggers for EBP" and "barriers to EBP". Subthemes related to "design matters", for example, "all about EBP in one place" and "a good overview of the steps within EBP"; motivated use of *EBPsteps*, and as such, worked as triggers. Design issues, such as unfamiliar icons, or problems using the app during clinical placements, were barriers students faced when using *EBPsteps*. Fig 2 illustrates the relationships between these three integrative themes.

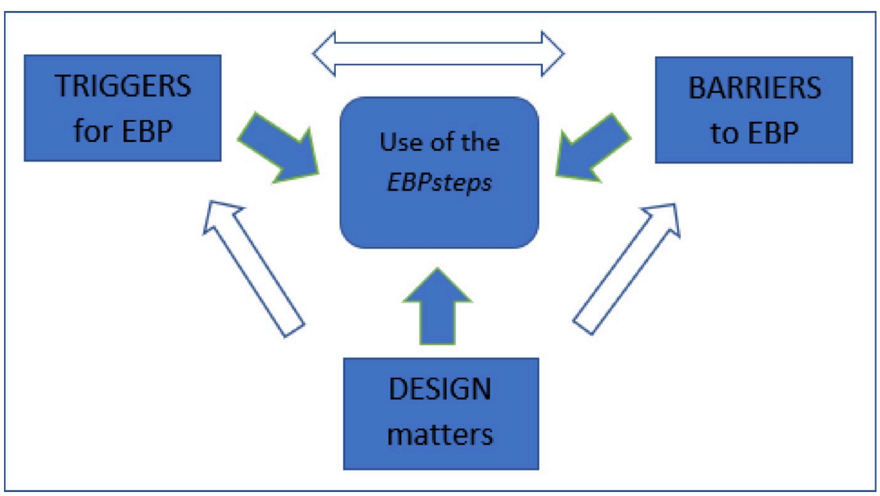

Fig 2. Patterns and themes related to use of the *EBPsteps*.

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Triggers for EBP

The use of the *EBPsteps* app was influenced by factors such as the need for information experienced in patient situations, course work requiring the use of research evidence, or clinical instructors expecting students to find and use research evidence.

Students across all interviews reported a need for more knowledge about the various challenges they encountered during clinical placements. Their information needs triggered them to retrieve research evidence and use the app. Several students mentioned that they wanted to find answers to questions about the effectiveness of interventions, such as fall prevention, exercise after pregnancy, or the use of weighted vests for children. As one student said:

> I was on placement in a nursery with children who demonstrated a lot of self-stimulation. The nursery staff used a weighted vest to calm children. Then, I discussed the effect of a weighted vest on self-stimulation with my clinical instructor, and my instructors suggested that I should search for research in that area. Consequently, I used the app (Stud.3, SE1).

The students were motivated to find research evidence, as they needed to justify their choices for the interventions they used in their clinical placements and to inform patients about interventions or treatments. It made a difference to students when they found research evidence. One student said: "Then you've got the answer: okay, it actually means something. You become more confident and start believing it more yourself. This also makes it easier to inform patients, having read that it [the intervention] works" (Stud.2, OT).

Five students from three interviews reported using the app when searching for research for assignments or exams and when they were required to apply EBP skills in clinical placements. Such academic requirements made using the app relevant to students. One student also emphasized that she tried to use the app because she wanted to learn and understand EBP in order to acquire the EBP competence that was required in the program: "I have to, because it [EBP] is a requirement in the take-home exam, and for the undergraduate dissertation and everything, and we must use it. So, I want to learn it. That is why I tried to use the app, because I want to understand it [EBP]" (Stud.3, SE2).

In three of the interviews, students reported situations where clinical instructors encouraged them to apply EBP, which triggered the use of the app. The app was a relevant tool when the students needed to search for research evidence. For example, one student was motivated to search for research evidence via the app when the clinical instructor challenged her to learn more about a specific diagnosis:

> During the clinical placement, I needed to learn more about a diagnosis and a specific challenge related to that diagnosis. I spoke with the clinical instructor, and she suggested that I spend some time investigating this topic. Then I needed to start searching. The app became relevant to use (Stud.1, SE1).

Barriers to EBP

Across all the interviews, we found several factors that hindered students from using the app during clinical placements, such as lack of EBP knowledge, lack of academic requirements, and instructors not prioritizing EBP.

Some of the students struggled to apply EBP and argued that EBP knowledge was a prerequisite for using the app. They believed their low level of EBP knowledge explained why they did not use the app, as illustrated by a quote from this student: "It [low level of EBP knowledge] is reflected in our use of the app. When we do not know what is behind it, we cannot do it. We cannot use it [*EBPsteps*], when we do not know anything about it [EBP] (Stud.2, SE2).

Some of the students thought they had to fill in all the elements under each EBP step within the app, which again required more in-depth EBP knowledge. Most students managed to fill in elements of the first two steps, which involved naming a topic and formulating a question, while the remaining steps were mostly not completed. None of the students seemed to understand what to write and why they had to fill in information for the last three EBP steps: the critical appraisal of evidence, application, and evaluation. Some students thought it would be helpful to have explanations of what to do for each step within the app: "I lacked information about how things work. Yes, it was assumed that we knew this from the start" (Stud.3, SE2). Another student commented: "There should have been a demonstration video with examples of how to do it" (Stud.5, SE2).

Two students reported that they had used the app to find information about specific exercises relevant for their clinical placements. As novices, they needed background information about particular therapy sessions and were probably less concerned with research evidence. They felt they had to go through too many steps in the app before they found helpful information for their practice. The students needed precise, practical information about the therapy, and they needed this quickly. As a result, they did not complete all the steps in the app:

> So, I thought it would be wise to look at the latest research and evaluate what is recommended and so forth. That is why I started using the app. However, I have to say that it was a bit too complicated, or not complicated, but there were too many steps before I got useful information because I needed practical, simple exercises [for the patient] (Stud.2, PT).

One student from social education reported no academic requirements or compulsory coursework that required the use of EBP during their clinical placement, and consequently, they did not have any incentive to use the app. As the student said: "I think one of the reasons why I did not write more in the app was that our third year of clinical placement did not require a written assignment" (Stud.1, SE1). Students from the OT and PT programs were required to use EBP in assignments and exams, although without specific documentation that they had followed the EBP steps. One student from physiotherapy worked through the EBP steps of reflection, question formulation, and literature search, which they were asked to do in an assignment. The students were, however, not required to critically appraise or summarize the research results, as illustrated by the following quote: "I only used what I had found to discuss in the assignment. I did not bother to use it [*EBPsteps*] further. I was satisfied because I had what I needed" (Stud.1, PT).

Students across interviews reported few incidences where clinical instructors required them to apply EBP, nor did they state whether their clinical instructors applied EBP. As one student said: "They did not ask about it [EBP] when I was on my clinical placement. The clinical instructors did not talk about it either" (Stud.1, PT).

In three of the interviews, students reported that much of their time during clinical placement was spent on hands-on, patient-related activities such as assessment, treatment, and documentation. EBP was not a priority, and neither was use of the app. After a day at work, one student reported that she was too tired to spend time looking for research. As the student explained: "There was a lot we had to do, document patient treatment after seeing patients, and. . . there was no time to try to find something [research]. There was more we had to do before we finished work. I was very tired when I got home" (Stud.2, PT).

Design matters

The students reported that some design features of the app motivated or hindered their use of the app. Design aspects that motivated use included the overview of the EBP steps, links to EBP resources, and the digital notebook feature. We also found examples of design-related features that impeded students' use of all the app's functions.

Students across all interviews found the app professional, understandable, transparent, and with a recognizable design. They appreciated that everything they needed to follow the EBP steps could be found in one place. Links to EBP resources were readily available, and students did not have to look for other sources on the web or in books, as reflected in a conversation between two students:

> I also like things to be systematic, and everything we need to work with EBP is in one place. It is very nice (Stud.2, PT). I agree. It is a good idea to have it all in one place so that you do not have to look through x numbers of folders on *itslearning* [digital learning management system]. Where was it again? It was very good. You did not have to browse the book from page to page (Stud.1, PT).

The students liked that they could simultaneously visualize all the EBP steps, which meant that they quickly achieved an overview of the EBP process. Several students found it helpful that links to relevant databases and web pages were provided within the app. Using the checklist integrated with the critical appraisal step in the app helped them understand research design. Students in two of the interviews found the steps understandable, making it straightforward to follow the EBP process. Therefore, the app's design helped students remember the EBP steps and prompted them to use the steps to structure the EBP process. As one student said: "I used it [*EBPsteps*] to make sure that I did it [the EBP process] in the correct order, that I did not skip a step. That is how it [*EBPsteps*] structured the process" (Stud.5, SE2).

The students reported that they used the app to write down ideas and thoughts during their clinical working day, and they appreciated the possibility of exploring the notes later. In this way, the app functioned as a digital notebook. They lacked time to complete all the EBP steps right away, and instead, they wrote down ideas or topics to complete the remaining steps later, as this student explained:

> It was very easy to pick it [*EBPsteps*] up and type in the theme and information needed. Then you could put it [*EBPsteps*] away and continue your search later. Usually, you would not have time to do it right away anyway. So, at least you could write themes down, and you knew where to find them. I found that very useful (Stud.2, SE1).

Although the students were positive about the app and its design, they experienced challenges that hindered use of the app. In one interview, three students explained that new web pages opened when they used links to databases in the app, and they had to make an extra maneuver to return to the app's webpage. The students were not motivated to complete the rest of the EBP steps after they had conducted searches on other web pages: "Yes, it becomes something separate, where the search was in a way detached from the app. For my part, I did not use the app after I had found research [on other web pages], and then it [*EBPsteps*] disappeared in a way" (Stud.3, SE1).

Some students experienced difficulties using the app during their clinical placements. One student explained that using the app felt awkward in the specific setting of their clinical placement:

> I did not have the opportunity to use the app in my situation because where I had my clinical placement, we [the student and clinical instructor] supervised the staff in a kindergarten. It might have been possible, but I did not feel that using the app in that situation was the right thing to do. So, for my part, I used the app at home (Stud.3, SE1).

Not all students discovered the app's various functions, such as the vertical three dots icon (. . .) for e-mails, edit button and trash, dictionary, calculator, or the plus sign (+) for creating new appraisals. Students did not realize that their appraisals were stored automatically, nor did everyone understand that they had to scroll down the page to complete all elements at each EBP step. Some students suggested that it would be helpful to have a demonstration video of how to use the app, with examples of how to complete the steps. Several students recommended specific changes to the app's design, as reflected by these students' comments: "I was not aware of the small three dots next to the dictionary" (Stud.2, OT). "Instead of having the three dots, is it possible to have a "letter," a "pen," and a "garbage bin" for example?" (Stud.1, OT).

Some students suggested that we included literature-search tips within the app. They emphasized that searching was difficult and time-consuming, and they did not know where to find databases. Some stated that they thought literature searches seemed easy when demonstrated by the teacher in class, but when they conducted searches themselves, they struggled and found little or nothing of relevance. Therefore, they wanted literature-search tips to be included in the app. Some students also suggested that the app could support their decisions by indicating relevant databases for different questions. One student reported: "Underneath your search, there is only a list [of databases], right. I think, if only they [the questions] could be linked to the databases, [. . .] or somehow be linked together, it would have made it easier" (Stud.3, SE1). Such guidance would have been helpful since the students struggled with identifying relevant databases. They found user manuals for the databases on the university website, but it was difficult for them to choose or find the right manual as there were so many of them.

Discussion

This study aimed to explore health and social care students' learning experiences about EBP using the mobile application *EBPsteps* during their clinical placements. Mobile applications for higher education must be developed and understood within the relevant educational context. When developing and implementing mobile apps, we need knowledge of how useful, satisfying, learnable, and accessible the users find the app [34]. Themes identified from the data, "triggers for EBP", "barriers to EBP", and "design matters" describe health and social care students' experiences using the *EBPsteps* app during clinical placements. We found that students who used the app were motivated to use it when they perceived it to be useful and relevant for learning EBP. This included if they needed to search for information, they were required to use the app for assignments, or when clinical instructors encouraged them to find or use research evidence. However, factors such as lack of EBP knowledge and lack of requirements to use EBP were perceived as barriers to using the app. The design of the app could both facilitate and hinder its use. The app's design was perceived as helpful as all EBP resources were collected in one place, although some technical issues such as poorly designed icons and navigation issues were perceived as barriers.

Requirements or the lack of requirements for using EBP in assignments worked as triggers or barriers towards EBP and the use of the app. Students reported that they used the app when EBP was required for assignments or when they were encouraged to apply EBP during their clinical placements. By contrast, when students lacked requirements or incentives for using

EBP, they prioritized other competing demands. Several studies report similar findings regarding competing demands and difficulties prioritizing [9, 11, 45, 46]. It seems that when students experience competing demands, they are likely to perceive apps as not useful or relevant and thus choose not to use them. Carlson [16] emphasized that when an app was not necessary for completing an EBP task, the students did not perceive it as relevant. Without incentives or relative advantages, students will most likely not use apps or other interventions [47]. Accordingly, exploring whether users experience apps as relevant and useful is an important part of testing the usability of apps [34].

The extent to which students chose to use the *EBPsteps* app during their clinical placements appeared to depend on whether the clinical instructors expected students to apply research evidence. As such, clinical instructors EBP behavior and their expectations of EBP behavior among students was either a barrier or a trigger towards EBP. In our study, we found that students did not use the *EBPsteps* app, for example, if they did not observe use of EBP by their clinical instructor or if EBP was not expected of them as students. Some clinical instructors encouraged students to apply EBP, and this triggered use of EBP and *EBPsteps*. These clinical instructors were perceived as EBP role models who showed that they understood and valued EBP. The systematic review by Thomas et al. [48] emphasized that clinical instructors should demonstrate, model, and guide students regarding expected EBP skills and behaviors. Ramis et al. [49] also recognized the value of experiencing EBP in clinical practice to motivate students to apply and appreciate the importance of EBP.

In addition to having EBP role models [9, 48, 49], the culture and rules for mobile phone usage at the workplace can influence the utilization of mobile apps [27]. A few of the students were concerned about how using mobile phones in a clinical setting would be perceived by staff and patients. Negative perceptions from health and social care professionals or patients can hinder students from using mobile phones during clinical placements [30], i.e., such perceptions worked as barriers to EBP and the use of the app. Concerns related to theft and the risk of transmitting infection may also restrict phone use [18, 27, 30]. For students to incorporate mobile apps as a learning tool during clinical placements, clinical instructors could advise students of when and how to use apps [27, 32]. The guidance could help balance the use of the app with other activities and support the learning transition. The socio-technical aspect of the mobile app, that is the integration of the app as part of the social world [47], needs to be considered when developing the app. Accessibility of the app is a component of usability testing [34]. The app will be used in a context, and students need support and guidance on when to use the *EBPsteps* during clinical placements.

In our study, a lack of EBP knowledge was reported as a barrier to EBP and use of the app. Previous research into implementing EBP among students recognized that students struggle to apply EBP due to a lack of confidence in their ability to engage with research and lack of time to work in an evidence-based way [11, 12, 45, 46]. To learn how to use EBP, it is recommended that students apply a five-step model [5], and the *EBPsteps* app was developed to support students in this process. Students in our study reported that the app structured the EBP process for them and facilitated the application of research evidence. Other studies have also registered improved EBP abilities among students' who used apps that support EBP [18–20]. Thus, it is likely that using apps that support EBP also helps students become informed change agents who can use their experience and critical thinking skills to question current behaviors in clinical practice [2–4].

Our results showed that design matters, as various design features influenced use of the app. Several of the students interviewed emphasized the possibility of using the app as a digital notebook to track ideas and questions. Queries that are not written down immediately often get lost, so it is useful to have a strategy to rapidly capture and save questions for later retrieval and searching [6]. One advantage of mobile devices is the possibility to use them when time and place are convenient [26]. Maudsley et al. [32] reported that having a digital notebook is useful for writing down questions and ideas and knowing where to find them. In this respect, *EBPsteps* is a helpful tool where students can gather information about clinical processes and be assisted by valuable e-learning resources integrated into the app. Consequently, apps and other technology are important drivers in transformative learning [2].

Exploring the perceived ease of use of the app is an element of usability testing [25]. Our findings revealed that students in this study struggled to find all the functions in the app, and as such, the design hindered use of the app. Low technology literacy and confidence have been identified as barriers to the use of mobile devices among students [30]. To meet these challenges, introducing the students to the features and interfaces of the application is essential [30, 32]. The successful implementation of technology in education requires technology to be integrated into the curriculum and for teachers to facilitate the use of technology [27, 32, 33]. Further development of the *EBPsteps* app will be necessary to make it even easier for students to use, for example, by automatizing searches for research.

How mobile learning strategies can support learning is worth investigating [28]. The students we interviewed received only a short introduction to the app's functions before their clinical placements, which may explain why some students struggled to identify and use all the functions of the *EBPsteps*. Therefore, future students should receive a more comprehensive introduction. In addition, we believe that active use of the app during various teaching situations, including classroom teaching, could facilitate a better understanding of how and when to use the app. Exposing students to several situations where the app can be used will likely also influence the students' perception of the app's relevance. This approach would be in line with recommendations that state that blended learning is an effective approach to teach EBP [14]. Such actions, where programs mobilize all learning channels, and the use of technology, underline the power of transformative learning [2]. To increase the use of *EBPsteps* during clinical placements, a thorough introduction to the app seems important, including thoughtful planning of how to best implement the *EBPsteps* app into the curriculum and teaching strategies/approaches.

Methodological considerations

One strength of this study was receiving feedback and experiences from the users to provide insight into how the app may be made more acceptable and helpful to users. Interviewing participants from different undergraduate programs provided different participant categories with various perspectives of experiences using *EBPsteps*. This form of data triangulation [50] allowed us to investigate the data's consistency from multiple perspectives, making the results more trustworthy [51]. By reading and re-reading the interviews, we were able to stay close to participants' contributions and, at the same time, interpret the data. Although we have provided information on how the interpretations were conducted, this is not the only way to interpret the data. Nevertheless, the results are consistent with the participants' descriptions and are an interpretive account of the data. Representative quotes from the data were selected to illustrate the interpretive claims of the data.

When developing a mobile application, it is suggested that the usability of the app should be examined by including five or six users, quickly identifying problems, and then improving the app's design [52]. Our sample consisted of 15 students. Focus groups are regarded as a relevant data collection tool to investigate user experience and are most commonly performed in the early stages of development to evaluate preliminary concepts with representative users [34]. The focus groups took place between two and five months after the students' clinical placements. This time-lapse may mean that students had forgotten details about using the app. In order to avoid pressuring students to say only positive things about the app, the interview guide included questions regarding both positive and negative experiences (S1 Appendix). As such, we received useful feedback for the further development of the *EBPsteps* app.

Conclusions

This study aimed to explore health and social care students' experiences of learning about EBP using the mobile application *EBPsteps* during their clinical placements. Three integrated themes described the use of the *EBPsteps*: "triggers for EBP", "barriers to EBP", and "design matters". We found that the students perceived the *EBPsteps* app as a relevant tool for learning EBP, although they also suggested specific changes to the design of the app. The use of the app was triggered by information need in placement, academic requirements, or clinical instructors who required or modeled EBP in placements. When using the app students faced barriers such as lack of EBP knowledge, lack of academic requirements, or EBP not being prioritized during clinical placement. Requirements must be embedded in the curriculum to ensure use of the app. The students' experiences with the *EBPsteps* are also relevant to a broader context of EBP teaching. Our findings bring important information to developing and implementing mobile apps as a teaching method in health and social care educations.

Supporting information

S1 Appendix. Focus groups interview guide.
(DOCX)

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II

Title

Occupational therapy students' evidence-based practice skills as reported in a mobile app: A cross-sectional study

Authors

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Abstract

Background: Evidence-based practice (EBP) is an important aspect of the healthcare education curriculum. EBP involves following the five EBP steps: Ask, Access, Appraise, Apply, and Audit. These five steps reflect the suggested core competencies covered in teaching and learning programs to support future healthcare professionals applying EBP. When implementing EBP teaching, assessing outcomes by documenting the student's performance and skills is relevant. This can be done using mobiles.

Objective: The aim of this study was to assess occupational therapy students' EBP skills as reported in a mobile app.

Methods: A cross-sectional design was applied. Descriptive statistics were used to present frequencies, percentages, mean, and range on data regarding EBP skills found in the *EBPsteps* app. Associations between students' ability to formulate PICO/PICo elements (abbreviation for Population, Intervention, Comparison, and Outcome/Population, Interest, and Context) and identifying relevant research evidence were analysed with the chi-square test.

Results: Of four cohorts with 150 students, 119 (79%) students used the app and produced 240 Critically Appraised Topics (CATs) in the app. The EBP steps Ask, Access, and Appraise were often correctly performed. The clinical question was formulated correctly in 67% (n=128) of the CATs, and students identified research evidence in 81% (n=195) of the CATs. Critical appraisal checklists were used in 81% (n=195) of the CATs, and most of these checklists were assessed as relevant for the type of research evidence identified (85%, n=165). The least frequently correctly reported steps were Apply and Audit. In 40% (n=95) of the CATs, it was reported that research evidence was applied. Only 61% (n=58) of these CATs described how the research was applied to clinical practice. Evaluation of practice changes was reported in 39% (n=93) of the CATs. However, details about practice changes were lacking in all these CATs. A positive association was found between formulating the Population and Interventions/Interest elements of the PICO/PICo and identifying research evidence ($p < 0.001$).

Conclusion: We assessed the students' EBP skills based on how they documented following the EBP steps in the *EBPsteps* app, and our results showed variations in how well the students mastered the steps. Apply and Audit were the most difficult EBP steps for the students to perform, and this finding has implications and gives directions for further development of the app and educational instruction in EBP. *EBPsteps* is a new and relevant app for students to learn and practice EBP and can be used for assessing the students' EBP skills objectively.

Keywords: active learning strategies, higher education, mobile apps, usability

Introduction

Evidence-based practice (EBP) involves using the best available evidence from relevant research, integrating it with clinical expertise, patient values and circumstances to make clinical decisions for individual patients [1]. When applying EBP, it is recommended to follow the five EBP steps: 1) identifying information needs and formulating answerable questions (Ask), 2) finding the best available evidence to answer clinical questions (Access), 3) critically appraising the evidence (Appraise), 4) applying the results in clinical practice (Apply), and 5) evaluating performance (Audit) [1, 2]. These five steps reflect the suggested core competencies covered in teaching and learning programs to support future healthcare professionals applying EBP, including developing EBP knowledge and skills [3].

EBP skills can be understood as applying EBP knowledge by performing EBP steps, ideally in a clinical setting [4]. The literature indicates that EBP knowledge and skills improve when EBP teaching and learning is multifaceted, interactive, clinically integrated, and incorporate assessment [5]. When implementing EBP teaching, it is relevant to document and assess the individual student's performance [3, 5, 6]. As it is recommended to follow all five EBP steps when teaching and learning EBP [1, 2], measuring the performance of all five steps is relevant when evaluating EBP learning. However, few evaluation instruments measure all five EBP steps [5-9], and most instruments are self-reported questionnaires [6, 7]. The use of self-reported questionnaires may contribute to biased results due to recall bias or social desirability response [9, 10]. Objectively measuring EBP learning could result in a true reflection of the situation, and thus, it is recommended to develop objective tools for EBP learning assessment [6, 7, 11]. To objectively document the performance of the EBP steps, Shaneyfelt et al. [6] emphasized using web-based documentation. Web-based documentation is feasible via mobile apps, and innovative new methods to evaluate EBP teaching can now be explored [12]. Most students own a smartphone, which makes mobile learning and information sharing possible [13, 14]. Thus, mobile apps can potentially be used for documenting and assessing students' EBP performance. The aim of this study was to assess occupational therapy students' EBP skills as reported in a mobile app.

Methods

This study used a cross-sectional design. The reporting of this study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist (Multimedia Appendix 1) [15].

Mobile app

A mobile web app called *EBPsteps* was developed at the Western Norway University of Applied Sciences (HVL) to support health and social care students' EBP learning [16]. An updated version of this web app is now freely available as a native app [17]. Experiences with using the *EBPsteps* for learning EBP have previously been explored [16]. The app provides an opportunity for students to document the five EBP steps. A description of the content of the *EBPsteps* app is presented in Table 1.

Table 1. The *EBPsteps* app content

EBP steps	Content in the *EBPsteps* app
Ask	- Reflect on information needs. - Formulate the clinical question. - Identify the type of clinical question (drop-down menu). - Identify the PICO*/PICo** elements.
Access	- Report information source used to identify research evidence. - Report links to research evidence identified.
Appraise	- Choose a relevant critical appraisal checklist. - Complete the critical appraisal using the integrated checklist.
Apply	- Report how research evidence was applied in practice (drop-down menu).
Audit	- Report if changes in practice were completed and evaluated. - Describe changes if changes were implemented. - Evaluate the EBP process (Ask, Access, Appraise, Apply, and Audit).

* PICO (Abbreviation for Population, Intervention, Comparison, and Outcome).
** PICo (Abbreviation for Population, Interest, and Context).

By documenting the EBP process in the app, students produced Critically Appraised Topics (CATs). A CAT can be explained as a summary of research evidence on a clinical question [18]. The CATs completed in the *EBPstep*s included information on all EBP steps, and the CATs could be sent via e-mail and shared as a PDF document. The CATs produced in the app were stored on the HVL research server and were accessible to the researchers in this project.

Participants

Four cohorts of fifth-semester occupational therapy (OT) students from different academic years (2018–2021) at HVL were eligible for inclusion if they used the *EBPsteps*.

Setting

In Norway, OT education is a three-year bachelor's degree of six semesters (180 European Credit Transfer System (ECTS)). According to the Norwegian national curriculum, all health and social care students must be able to acquire new knowledge and make professional assessments, decisions, and actions in line with EBP [19]. At the time of this study, EBP was well integrated into the OT bachelor's degree program at HVL [20].

Table 2 provides an overview of the total amount of standalone EBP sessions (n=27) that OT students in this study received by their fifth semester (year three). This amount of EBP teaching hours is a high number [21]. In addition, EBP was integrated into other learning activities, such as Problem-Based Learning (PBL) group activities, written assignments, and exams.

Table 2. Overview of standalone EBP sessions

Year 1		Year 2		Year 3*		
Standalone sessions about:	Hours	Standalone sessions about:	Hours	Standalone sessions about:	Hours	Total hours
Ask	2	Ask	1	Ask	2	
Assess	2	Assess	1	Assess	2	
		Appraise	3	Appraise	8	
		Apply	2	Apply	3	
				Audit	1	
	4		7		16	27

* Includes sessions given through 5th semester only

Using the *EBPsteps* was part of the EBP teaching. Students were introduced to the app at the start of the fifth semester. The students watched a video presentation of how to use the app and explored using the app while supervised by a teacher. During the fifth semester, the students were encouraged to use the *EBPsteps* app at campus (4 weeks) and during clinical placements (11 weeks). While at the campus, students had to use either the *EBPsteps* or a Word document to complete a mandatory EBP assignment that involved producing a CAT on a clinical topic. Similarly, at the end of the semester, an appendix to the home exam was to use either the *EBPsteps* or a Word document to produce a CAT.

Data collection

CATs produced by students during the fifth semester were exported from students' *EBPsteps* user accounts to Microsoft Excel® [22] at the end of the semester. The Norwegian data, anonymized by authors, is freely available via HVL Open [23] and includes our assessment.

To objectively assess students' EBP skills based on how they documented the EBP process in the app, we developed a scoring plan for each EBP step in the CATs (see Multimedia Appendix 2). The different steps of the CATs were assessed as correct or incorrect, which were the outcomes investigated in this study. Two researchers independently scored each CAT, and disagreements were resolved through discussion. An overview of the scoring plan is presented in Table 3.

Table 3. Overview of the scoring plan

EBP steps	What was assessed?
Ask	Was it reflected on the information needs?
	Which clinical question was formulated? (e.g. prevalence, cause, diagnostics, effect of measures, prognosis, or experiences and attitudes)
	Which clinical question was identified (drop-down menu)?
	Was there an agreement between the formulated clinical question and the type of question identified from the drop-down menu?
	Was the Population of the PICO*/PICo** correctly reported?
	Was the Intervention/Interest of the PICO*/PICo** correctly reported?
	Was the Comparison of the PICO*/PICo** correctly reported?
	Was the Outcome/Context of the PICO*/PICo** correctly reported?
Access	Which information sources were used? (e.g. BMJ Best Practice, Cochrane Library, PubMed)
	Was a link to research evidence reported?
	Was there an agreement between the information source used and the identified research evidence?
Appraise	Was there an agreement between the identified research evidence and the chosen critical appraisal checklist used?
	Were the questions in the checklist completed?
Apply	Was the application of the research evidence reported (drop-down menu)?
	If reported applied, was this described?
Audit	Were changes in practice evaluated?
	Was the EBP process evaluated?

* PICO (Abbreviation for Population, Intervention, Comparison, and Outcome).
** PICo (Abbreviation for Population, Interest, and Context).

Analysis

Descriptive statistics were used to summarise the assessment of students' EBP skills based on the completed CATs, including frequencies and percentages for categorical variables and mean and range for continuous variables. Associations between correctly identifying PICO/PICo elements and finding research evidence were analysed with the chi-square test with adjustment for repeated measurements [24]. The significance level was set at 5%. Statistical analyses were performed with SPSS Statistics, version 28.0 [25] and R [26].

Ethical considerations

The Norwegian Agency for Shared Services in Education and Research (Sikt) approved the study (project no. 50425). The students were informed, both orally and in writing, about the purpose of this study and that the data would be treated confidentially. The students agreed to participate in the study and signed a consent form when they created a profile and used the *EBPsteps*. The students did not receive any compensation for participating. Students could choose to use the app or a Word document to complete assignments where it was required to produce CATs. The data were securely stored on the research server at HVL.

Results

Among four cohorts with occupational therapy students, 119 (79%) out of 150 students used the *EBPsteps* during their fifth semester. The students who used the app produced 240 CATs (Table 4). The mean number of CATs produced per student was two, with a range from one to seven.

Table 4. The number of students who used the *EBPsteps* and CATs produced

	2018	**2019**	**2020**	**2021**	**Total**
No. of students	41/47	25/30	21/33	32/40	119/150
No. of CATs*	73	53	43	71	240

* CATs = Critically Appraised Topics

Step 1: Ask

A need for more knowledge on a clinical problem was reported in 227 of the 240 CATs (95%). In 80% (n=192) of the CATs, the type of clinical question was identified using a drop-down menu. A clinical question was formulated in 67% (n=128) of the CATs. The 'effect of therapy' was the most prevalent clinical question reported (52%, n=100) (Figure 1).

All PICO/PICo elements were reported correctly in 10% (n=25) of the CATs. Assessing the different PICO/PICo elements separately, the Population and Intervention/Interest elements were more often correctly reported (78% and 79%) than the Comparison and Outcome/Context elements (18% and 43%). This applied to all question types, including when the question had been formulated as a background question (Figure 1). In CATs without a clinical question identified, most PICO/PICo elements were incorrectly reported.

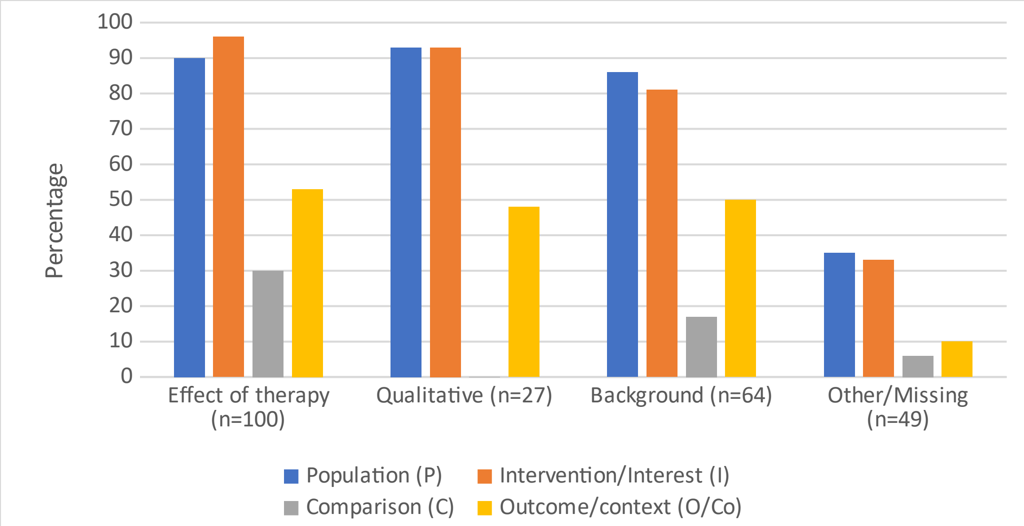

Figure 1: Percentage of correctly reported PICO/PICo elements by type of question in 240 CATs

Step 2: Access

In 240 of the CATs, the information source most frequently reported was the Cochrane Library (27%), followed by Cinahl (18%), PubMed (15%), and Epistemonikos (7%). In 13% of the CATs, no information source was reported used. Research evidence was identified and linked to in 81% of the CATs, and the most common type of research evidence identified was systematic reviews (n=85), randomised controlled trials (RCTs) (n= 51), and qualitative research (n=44).

We observed a positive association between correctly reporting Population and Intervention/Interest elements of the PICO/PICo and identifying research evidence. Among those correctly reporting the Population element, 92% identified research evidence, compared to 52% among those that did not report the Population element ($p < 0.001$). Similar findings were observed for the Intervention/Interest element.

Step 3: Appraise

A checklist was used in 81% (n=195) of the CATs. Of these, the correct checklist was used in 85% (n=165) of the CATs, i.e. there was an agreement between the type of checklist and research evidence identified (Table 5).

Table 5. Type of research evidence identified and agreement with choice of checklist

Type of research evidence	n	The agreement between research evidence and checklist, n (%)
Systematic Reviews	85	77 (89%)
Randomised Controlled Trials (RCTs)	51	42 (82%)
Qualitative research	44	42 (95%)
Guidelines	4	2 (50%)
Observational studies*	11	2 (18%)
The total number of research evidence identified	**195**	**165 (85%)**

* Included the following study designs: prevalence (n=1), diagnostic (n=1), cohort (n=3), case-control (n=1) and cross-section (n=5)

In 98% of the CATs with a correct checklist, more than 75% of the checklist questions had been answered. Effect estimates reported in identified research evidence were documented in 27% (n=21) of the checklists for systematic reviews and 36% (n=15) for RCTs.

Step 4: Apply

In 40% (n=95) of the CATs, it was reported that research evidence was applied in clinical practice. How the research was applied was described sufficiently in only 61% (n=58) of these CATs.

The most common shared decision-making approach reported from a drop-down menu was 'identifying preferences' and 'explored possibilities' (Figure 2).

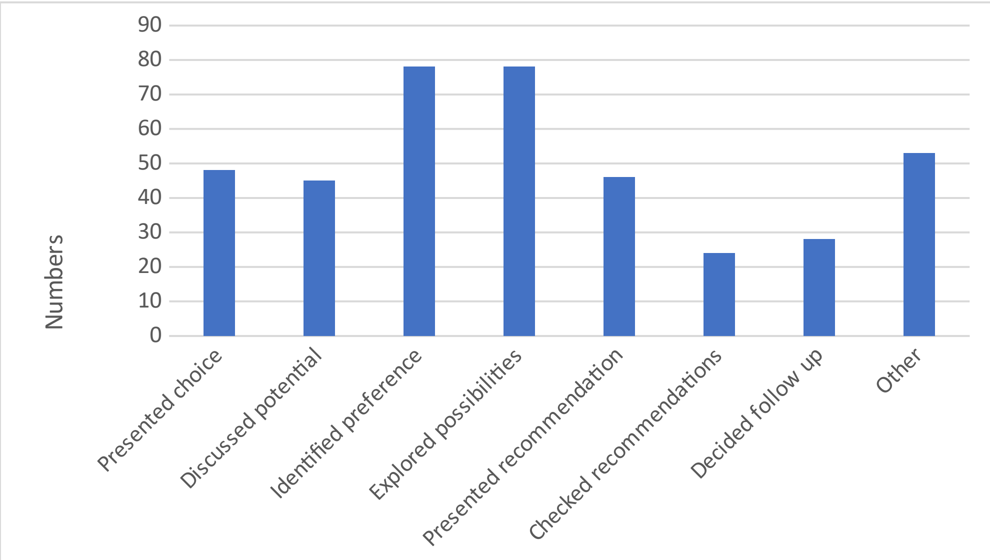

Figure 2. Reported numbers of shared decision-making approaches

Step 5: Audit

Evaluation of practice changes was reported in 39% (n=93) of the CATs. However, details of practice changes were lacking in all these CATs. In 46% (n=43) of the CATs that reported evaluation, it was reported 'did not change practice', and in 54% (n=50) of these CATs, it was reported that it was 'not relevant to change practice'. The EBP process was reported as evaluated in 55% (n=131) of the CATs.

Discussion

Principal Findings

This study assessed OT students' EBP skills as reported in the *EBPsteps* mobile app. We found that students most often were able to perform the EBP steps Ask, Access, and Appraise correctly. A positive association was found between formulating the PICO/PICo elements and identifying research evidence. Applying the evidence and evaluating practice change were the least frequently correctly reported steps of the EBP process.

Comparison to Prior Work

Using data from the *EBPsteps*, where students had documented how they followed the EBP process for their clinical question, enabled us to collect objective data on students' EBP skills. Instruments that objectively measure EBP skills are recommended for acquiring a true reflection of the situation [6, 7, 11], as opposed to more frequently used self-report assessment tools [6, 7]. Although objective assessment is advised, it can be time-consuming to complete and assess [4]. Consequently, self-reported questionnaires are often chosen because of their practicality of administration [9]. Developing an easy-to-administer scoring plan for the *EBPsteps* has therefore been important. Against this background, the *EBPsteps* can be a valuable contribution to objectively assessing EBP skills related to all five steps of the EBP process.

Ask and Access

We found a positive association between correctly reporting Population and Intervention/Interest elements of the PICO/PICo and finding research evidence, indicating that completing the PICO/PICo supports students' ability to retrieve relevant research evidence. These findings align with previous research reporting that a clearly defined question supports students' ability to retrieve relevant information [27, 28]. Furthermore, structuring the question using the PICO format makes it easier to decide on search terms [2].

Appraise

The appropriate critical appraisal checklist was chosen in 79% of the CATs in this study. Nevertheless, few effect estimates were reported in checklists for RCTs and systematic reviews. This might suggest that the students had difficulties interpreting the statistical results. Lack of confidence in interpreting statistical results has previously been reported among health and social care students [29, 30]. Acquiring an understanding of effect estimates is necessary when applying EBP [3], and spending more time teaching the understanding of research results to support the students learning and interpretation of research results is recommended [31].

Apply and Audit

Only about half of the students in our study reported that they applied research evidence they found, indicating that they struggled using EBP skills beyond the classroom setting, which also correlates with previous research [32, 33]. Lehane et al. [34] suggest that structural incorporation of EBP during clinical placement, for instance, via easy access to research, EBP mentors, or regular journal clubs, may support the students in applying research evidence. In addition, incorporating assessment of EBP in clinical placement has been shown to influence EBP behaviour [5]. In our study, EBP assignments were mandatory in class but not during clinical placement, which may explain why students in this study struggled with the steps applying and evaluating practice. Providing a mandatory EBP assignment during the clinical placement may support the students in applying EBP and thus also mastering the two last steps of the EBP process.

An alternative explanation to why students struggled with the steps applying and evaluating practice could be that the students experienced fatigue or other difficulties using the app. To explore whether other issues influenced students' skills, we could have further tested the usability of the app. When developing mobile apps for teaching and learning, usability testing is important [35]. Other research methods are necessary to investigate why the two last steps of the EBP process were less frequently completed. Future research should include cognitive interview studies (e.g. think-aloud methods) and other pilot studies in different populations to evaluate comprehensiveness and comprehensibility of the app.

Future directions

Knowledge of which EBP steps students find most challenging has implications and gives directions for further development of the *EBPsteps* app and educational instruction in EBP. For example, providing a more comprehensive explanation of how to interpret statistical results in the app could be beneficial. In addition, spending more time teaching statistics and how to read the results seems necessary to improve students' EBP performance.

A better alignment between what is taught during classes on campus and what students do at placements could also perhaps better facilitate EBP behaviour among students. A mandatory assignment where research evidence must be found and discussed with the clinical instructors may help the students apply and evaluate the use of research evidence during clinical placement.

Currently, *EBPsteps* is available only in Norwegian. In the future, we aim to provide user interface translations for several languages [16]. However, we will need to modify options in the app according to free access resources available in the different countries (e.g. databases, guidelines, e-learning resources). Efforts will be made to find the best solution and to accommodate needs in low- and middle-income countries.

Methodological considerations

The main limitation of this study was that we included students from only one profession and from the same educational institution, and thus the generalisability of the results to other institutions and to other health and social care students is reduced. However, the sample consisted of four student cohorts from different academic years (2018–2021) (n=119), including 240 CATs. Accordingly, we believe the results from this study can be recognisable and relevant across other populations.

A strength of this study is that the *EBPsteps* allow us to objectively measure the performance of the EBP process using an app that includes all five EBP steps. It is recommended that educators select instruments that objectively measure EBP performance [11]. Shaneyfelt et al. [6] emphasized the use of web-based documentation of the EBP steps as a promising approach.

Another strength was that two researchers assessed the CATs independently based on a scoring plan, and disagreement was solved through discussion. However, the *EBPsteps* and the scoring plan are not validated for assessing EBP, and measurement properties should be examined in future studies.

Conclusions

We assessed the students' EBP skills based on how they documented following the EBP steps in the *EBPsteps* app, and our results showed variations in how well the students mastered the steps. Apply and Audit were the most difficult EBP steps for the students to perform, and this finding has implications and gives directions for further development of the app and educational instruction in EBP. *EBPsteps* is a new and relevant app for students to learn EBP and can be valuable for assessing EBP skills objectively.

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Conflicts of Interest

No funding was received for conducting this study, and the authors declare they have no financial interests.

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Funding acquisition: NRO

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Project administration: SGJ and NRO

Resources: Johannes Mario Ringheim (JMR), SGJ, BE and NRO

Software: JMR

Supervision: BE, LL, DC, and NRO

Validation: SGJ, BE and NRO

Visualization: SGJ and NRO

Writing – original draft: SGJ

Writing – review & editing: SGJ, BE, LL, DC, and NRO

Multimedia Appendix 1

STROBE checklist

Multimedia Appendix 2

The scoring plan of the *EBPsteps*

Data Availability

The Norwegian data, anonymized by authors, are publicly and freely available via HVL Open [23].

Generative AI

Generative AI was not used in the manuscript writing.

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List of abbreviations

CATs: Critically Appraised Topics

EBP: Evidence-based practice

ECTS: European Credit Transfer System

HVL: Western Norway University of Applied Sciences

OT: Occupational therapy

PBL: Problem-Based Learning

PICO: Population, Intervention, Comparison, and Outcome

PICo: Population, Interest, and Context

RCT: Randomised Controlled Trial

Sikt: Norwegian Agency for Shared Services in Education and Research

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology checklist

III

Review

Usability Methods and Attributes Reported in Usability Studies of Mobile Apps for Health Care Education: Scoping Review

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Abstract

Background: Mobile devices can provide extendable learning environments in higher education and motivate students to engage in adaptive and collaborative learning. Developers must design mobile apps that are practical, effective, and easy to use, and usability testing is essential for understanding how mobile apps meet users' needs. No previous reviews have investigated the usability of mobile apps developed for health care education.

Objective: The aim of this scoping review is to identify usability methods and attributes in usability studies of mobile apps for health care education.

Methods: A comprehensive search was carried out in 10 databases, reference lists, and gray literature. Studies were included if they dealt with health care students and usability of mobile apps for learning. Frequencies and percentages were used to present the nominal data, together with tables and graphical illustrations. Examples include a figure of the study selection process, an illustration of the frequency of inquiry usability evaluation and data collection methods, and an overview of the distribution of the identified usability attributes. We followed the Arksey and O'Malley framework for scoping reviews.

Results: Our scoping review collated 88 articles involving 98 studies, mainly related to medical and nursing students. The studies were conducted from 22 countries and were published between 2008 and 2021. Field testing was the main usability experiment used, and the usability evaluation methods were either inquiry-based or based on user testing. Inquiry methods were predominantly used: 1-group design (46/98, 47%), control group design (12/98, 12%), randomized controlled trials (12/98, 12%), mixed methods (12/98, 12%), and qualitative methods (11/98, 11%). User testing methods applied were all think aloud (5/98, 5%). A total of 17 usability attributes were identified; of these, satisfaction, usefulness, ease of use, learning performance, and learnability were reported most frequently. The most frequently used data collection method was questionnaires (83/98, 85%), but only 19% (19/98) of studies used a psychometrically tested usability questionnaire. Other data collection methods included focus group interviews, knowledge and task performance testing, and user data collected from apps, interviews, written qualitative reflections, and observations. Most of the included studies used more than one data collection method.

Conclusions: Experimental designs were the most commonly used methods for evaluating usability, and most studies used field testing. Questionnaires were frequently used for data collection, although few studies used psychometrically tested questionnaires. The usability attributes identified most often were satisfaction, usefulness, and ease of use. The results indicate that combining different usability evaluation methods, incorporating both subjective and objective usability measures, and specifying which usability attributes to test seem advantageous. The results can support the planning and conduct of future usability studies for the advancement of mobile learning apps in health care education.

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KEYWORDS

user-computer interface; mobile apps; online learning; health education; students

Introduction

Background

Mobile devices can provide extendable learning environments and motivate students to engage in adaptive and collaborative learning [1,2]. Mobile devices offer various functions, enable convenient access, and support the ability to share information with other learners and teachers [3]. Most students own a mobile phone, which makes mobile learning easily accessible [4]. However, there are some challenges associated with mobile devices in learning situations, such as small screen sizes, connectivity problems, and multiple distractions in the environment [5].

Developers of mobile learning apps need to consider usability to ensure that apps are practical, effective, and easy to use [1] and to ascertain that mobile apps meet users' needs [6]. According to the International Organization for Standardization, usability is defined as "the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [7]. Better mobile learning usability will be achieved by focusing on user-centered design and attention to context, ensuring that the technology corresponds to the user's requirements and putting the user at the center of the process [8,9]. In addition, it is necessary to be conscious of the interrelatedness between usability and pedagogical design [9].

A variety of usability evaluation methods exists to test the usability of mobile apps, and Weichbroth [10] categorized them into the following 4 categories: inquiry, user testing, inspection, and analytical modeling. Inquiry methods are designed to gather data from users through questionnaires (quantitative data) and interviews and focus groups (qualitative data). User testing methods include think-aloud protocols, question-asking protocols, performance measurements, log analysis, eye tracking, and remote testing. Inspection methods, in contrast, involve experts testing apps, heuristic evaluation, cognitive walk-through, perspective-based inspections, and guideline reviews. Analytical modeling methods include cognitive task analysis and task environment analysis [10]. Across these 4 usability evaluation methods, the most commonly used data collection methods are controlled observations and surveys, whereas eye tracking, think-aloud methods, and interviews are applied less often [10].

Usability evaluations are normally performed in a laboratory or in field testing. Previous reviews have reported that usability evaluation methods are mainly conducted in a laboratory, which means in a controlled environment [1,11]. By contrast, field testing is conducted in real-life settings. There are pros and cons to the 2 different approaches. Field testing allows data collection within a dynamic environment, whereas in a laboratory data collection and conditions are easier to control [1]. A variety of data collection methods are appropriate for usability studies; for instance, in laboratories, participants performing predefined tasks, such as using questionnaires and observations, are often applied [1]. In field testing, logging mechanisms and diaries have been applied to capture user interaction with mobile apps [1].

In all, 2 systematic reviews examined various psychometrically tested usability questionnaires as a means of enhancing the usability of apps. Sousa and Lopez [12] identified 15 such questionnaires and Sure [13] identified 13. In all, 5 of the questionnaires have proven to be applicable in usability studies in general: the System Usability Scale (SUS), Questionnaire for User Interaction Satisfaction, After-Scenario Questionnaire, Post-Study System Usability Questionnaire, and Computer System Usability Questionnaire [12]. The SUS questionnaire and After-Scenario Questionnaire are most widely applied [13]. The most frequently reported usability attributes of these 5 questionnaires are learnability, efficiency, and satisfaction [12].

Usability attributes are features that measure the quality of mobile apps [1]. The most commonly reported usability attributes are effectiveness, efficiency, and satisfaction [5], which are part of the usability definition [7]. In the review by Weichbroth [10], 75 different usability attributes were identified. Given the wide selection of usability attributes, choosing appropriate attributes depends on the nature of the technology and the research question in the usability study [14]. Kumar and Mohite [1] recommended that researchers present and explain which usability attributes are being tested when mobile apps are being developed.

Previous reviews have examined the usability of mobile apps in general [5,10,11,14,15]; however, only one systematic review has specifically explored the usability of mobile learning apps [1]. However, studies from health care education were not included. Similarly, usability has not been widely explored in medical education apps [16]. Thus, there is a need to develop a better understanding of how the usability of mobile learning apps developed for health care education has been evaluated and conceptualized in previous studies.

Objectives

The aim of this scoping review has therefore been to identify usability methods and attributes in usability studies of mobile apps for health care education.

Methods

Framework

We have used the framework for scoping reviews developed by Arksey and O'Malley [17] and further developed by Levac et al [18] and Khalil et al [19]. We adopted the following five stages of this framework: (1) identifying the research question, (2) identifying relevant studies, (3) selecting studies, (4) charting the data, and (5) summarizing and reporting the results [17-19].

A detailed presentation of each step can be found in the published protocol for this scoping review [20]. We followed the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist for reporting scoping reviews (Multimedia Appendix 1 [21]).

Stage 1: Identifying the Research Question

The following two research questions have been formulated:

1. Which usability methods are used to evaluate the usability of mobile apps for health care education?
2. Which usability attributes are reported in the usability studies of mobile apps for health care education?

Stage 2: Identifying Relevant Studies

A total of 10 electronic databases on technology, education, and health care from January 2008 to October 2021 and February 2022 were searched. These databases were as follows: Engineering Village, Scopus, ACM Digital Library, IEEE Xplore, Education Resource Information Center, PsycINFO, CINAHL, MEDLINE, EMBASE, and Web of Science. The search string was developed by the first author and a research librarian and then peer reviewed by another research librarian. The search terms used in the Web of Science, in addition to all relevant subject headings, included: *((student* or graduate* or undergraduate* or postgraduate*) NEAR/3 nurs*)*. This search string was repeated for other types of students and combined with the Boolean operator OR. The search string for all types of health care students was then combined with various search terms for mobile apps and mobile learning using the Boolean operator AND. Similar search strategies were used and adapted for all 10 databases as shown in Multimedia Appendix 2. In addition, a citation search in Google Scholar, screening reference lists of included studies, and searching for gray literature in OpenGrey were conducted.

Stage 3: Selecting Studies

Two of the authors independently screened titles and abstracts using Rayyan web-based management software [22]. Studies deemed eligible by one of the authors were included for full-text screening and imported into the EndNote X9 (Clarivate) reference management system [23]. Eligibility for full-text screening was determined independently by two of the authors and disagreements were resolved by consensus-based discussions. Research articles with different designs were included, and there were no language restrictions. As mobile apps started appearing in 2008, this year was set as the starting point for the search. Eligibility criteria are presented in Table 1.

Table 1. Study eligibility.

	Inclusion criteria	Exclusion criteria
Population	Health care and allied health care students at the undergraduate and postgraduate levels	Health care professionals or students from education, engineering, or other nonhealth sciences
Concept	Studies of usability testing or methods of usability evaluation of mobile learning apps where the purpose relates to the development of the apps	Studies relating to learner management systems, e-learning platforms, open online courses, or distance education
Context	Typical educational setting (eg, classroom teaching, clinical placement, or simulation training), including both synchronous and asynchronous teaching	Noneducational settings not involving clinical placement or learning situations (eg, hospital or community settings)

Stage 4: Charting the Data (Data Abstraction)

The extracted data included information about the study (eg, authors, year of publication, title, and country), population (eg, number of participants), concepts (usability methods, usability attributes, and usability phase), and context (educational setting). The final data extraction sheet can be found in Multimedia Appendix 3 [24-111]. One review author extracted the data from the included studies using Microsoft Excel software [21], which was checked by another researcher.

Descriptions of usability attributes have not been standardized, making categorization challenging. Therefore, a review author used deductive analysis to interpret the usability attributes reported in the included studies. This interpretation was based on a review of usability attributes as defined in previous literature. These definitions were assessed on the basis of the results of the included studies. This analysis was reviewed and discussed by another author. Disagreements were resolved through a consensus-based discussion.

Stage 5: Summarizing and Reporting the Results

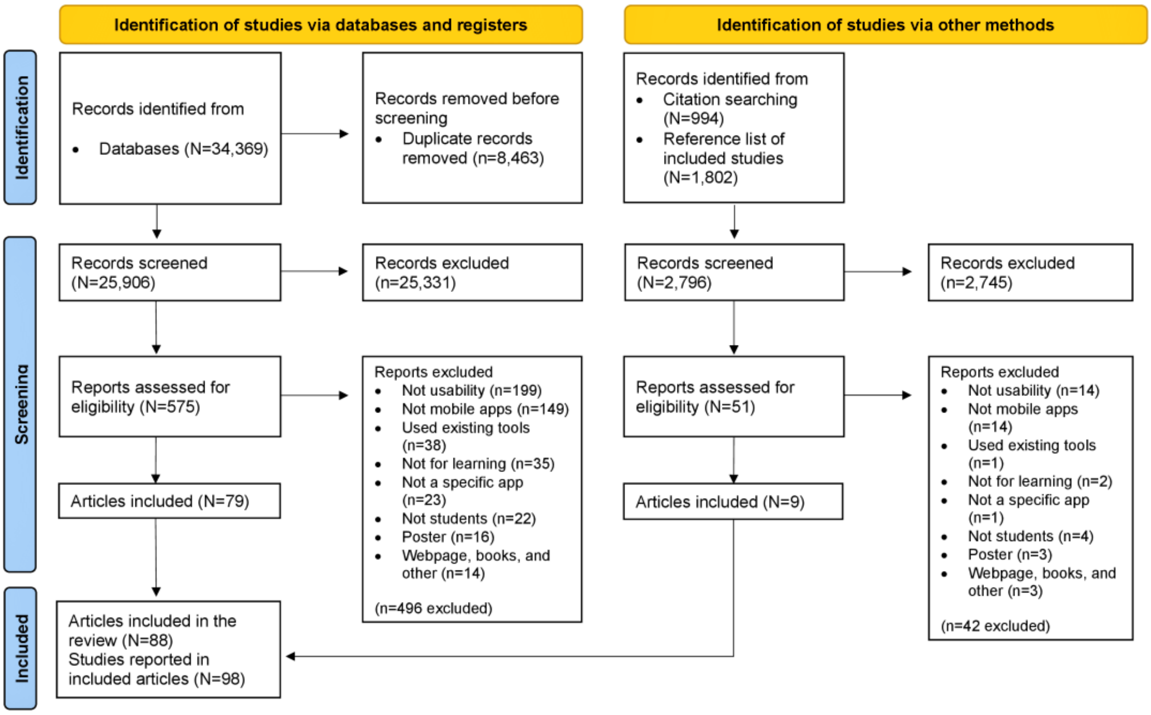
Frequencies and percentages were used to present nominal data, together with tables and graphical illustrations. For instance, a figure showing the study selection process, an illustration of the frequency of inquiry-based usability evaluation and data collection methods, and an overview of the distribution of identified usability attributes were provided.

Results

Eligible Studies

Database searches yielded 34,369 records, and 2796 records were identified using other methods. After removing duplicates, 28,702 records remained. A total of 626 reports were examined in full text. In all, 88 articles were included in the scoping review [24-111] (Figure 1). A total of 8 articles comprised results from several studies in the same article, presented as study A, study B, or study C in Multimedia Appendix 3. Therefore, a total of 98 studies were reported in the 88 articles included.

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart of study selection process.



The included studies comprised a total sample population of 7790, with participant numbers ranging from 5 to 736 participants per study. Most of the studies included medical students (34/88, 39%) or nursing students (25/88, 28%). Other participants included students from the following disciplines: pharmacy (9/88, 10%), dentistry (5/88, 6%), physiotherapy (5/88, 6%), health sciences (3/88, 3%), and psychology (2/88, 2%). Further information is provided in Multimedia Appendix 3. There were 22 publishing countries, with most studies being from the United States (22/88, 25%), Spain (9/88, 10%), the United Kingdom (8/88, 9%), Canada (7/88, 8%), and Brazil (7/88, 8%), with an increasing number of publications from 2014. Table 2 provides an overview and characteristics of the included articles.

Table 2. Characteristics of included articles.

Study number	Study	Population (N)	Research design: data collection method	Usability attributes
1	Aebersold et al [24], 2018, United States	Nursing (N=69)	Mixed methods: questionnaire; task and knowledge performance[a]	Ease of use; learning performance; satisfaction; usefulness
2	Akl et al [25], 2008, United States	Resident (N=30)	Qualitative methods: focus groups; written qualitative reflections	Satisfaction
3	Al-Rawi et al [26], 2015, United States	Dentist (N=61)	Posttest 1-group design: questionnaire	Ease of use; frequency of use; satisfaction; usefulness
4	Albrecht et al [27], 2013, Germany	Medicine (N=6)	Posttest 1-group design: questionnaire[b]	Satisfaction
5	Alencar Neto et al [28], 2020, Brazil	Medicine (N=132)	Posttest 1-group design: questionnaire[b]	Ease of use; learnability; satisfaction; usefulness
6	Alepis and Virvou [29], 2010, Greece	Medicine (N=110)	Mixed methods: questionnaire; interviews	Ease of use; usefulness; user-friendliness
7	Ameri et al [30], 2020, Iran	Pharmacy (N=241)	Posttest 1-group design: questionnaire[b]	Context of use; efficiency; usefulness
8	Balajelini and Ghezeljeh [31], 2018, Iran	Nursing (N=41)	Posttest 1-group design: questionnaire	Ease of use; frequency of use; navigation; satisfaction; simplicity; usefulness
9	Barnes et al [32], 2015, United Kingdom	Medicine (N=42)	Randomized controlled trial: questionnaire; task and knowledge performance	Ease of use; effectiveness; learning performance; satisfaction
10	Busanello et al [33], 2015, Brazil	Dentist (N=62)	Pre-post test, nonrandomized control group design: questionnaire[b]	Learnability; learning performance; satisfaction
11	Cabero-Almenara and Roig-Vila [34], 2019, Spain	Medicine (N=50)	Pre-post test, 1-group design: questionnaire[b]	Learning performance; satisfaction
12	Choi et al [35], 2015, South Korea	Nursing (N=5)	Think-aloud methods: interviews; data from app	Context of use; ease of use; learnability; satisfaction; usefulness
13	Choi et al [36], 2018, South Korea	Nursing (N=75)	Pre-post test, nonrandomized control group design: questionnaire	Ease of use; learning performance; satisfaction; usefulness
14	Choo et al [37], 2019, Singapore	Psychology (N=8)	Mixed methods: questionnaire[b]; written qualitative reflections	Ease of use; learning performance; satisfaction; usefulness; user-friendliness
15	Chreiman et al [38], 2017, United States	Medicine (N=30)	Posttest 1-group design: questionnaire; data from app	Context of use; ease of use; frequency of use; usefulness
16	Colucci et al [39], 2015, United States	Medicine (N=115)	Posttest 1-group design: questionnaire	Effectiveness; efficiency; satisfaction; usefulness
17	Davids et al [40], 2014, South Africa	Residents (N=82)	Randomized controlled trial: questionnaire[b]; data from app	Effectiveness; efficiency; learnability; navigation; satisfaction; user-friendliness
18A	Demmans et al [41], 2018, Canada	Nursing (N=60)	Pre-post test, nonrandomized control group design: questionnaire; observations	Ease of use; effectiveness; learnability; learning performance; navigation; satisfaction
18B	Demmans et al [41], 2018, Canada	Nursing (N=85)	Pre-post test, nonrandomized control group design: questionnaire; observations	Ease of use; effectiveness; learnability; learning performance; navigation; satisfaction

Study number	Study	Population (N)	Research design: data collection method	Usability attributes
19	Devraj et al [42], 2021, United States	Pharmacy (N=89)	Posttest 1-group design: questionnaire; data from app	Ease of use; errors; frequency of use; learning performance; navigation; operational usability; satisfaction; usefulness
20	Díaz-Fernández et al [43], 2016, Spain	Physiotherapy (N=110)	Posttest 1-group design: questionnaire	Comprehensibility; ease of use; usefulness
21	Docking et al [44], 2018, United Kingdom	Paramedic (N=24)	Think-aloud methods: focus groups	Context of use; learnability; satisfaction; usefulness
22	Dodson and Baker [45], 2020, United States	Nursing (N=23)	Qualitative methods: focus groups	Ease of use; operational usability; satisfaction; usefulness; user-friendliness
23	Duarte Filho et al [46], 2014, Brazil	Medicine (N=10)	Posttest nonrandomized control group design: questionnaire	Ease of use; efficiency; satisfaction; usefulness
24	Duggan et al [47], 2020, Canada	Medicine (N=80)	Posttest 1-group design: questionnaire; data from app	Ease of use; frequency of use; satisfaction; usefulness
25	Fernandez-Lao et al [48], 2016, Spain	Physiotherapy (N=49)	Randomized controlled trial: questionnaire[b]; task and knowledge performance	Learning performance; satisfaction
26	Fralick et al [49], 2017, Canada	Medicine (N=62)	Pre-post test, nonrandomized control group design: questionnaire	Ease of use; frequency of use; learning performance; usefulness
27	Ghafari et al [50], 2020, Iran	Nursing (N=8)	Posttest 1-group design: questionnaire	Ease of use; operational usability; satisfaction; usefulness
28	Goldberg et al [51], 2014, United States	Medicine (N=18)	Posttest 1-group design: questionnaire; task and knowledge performance	Ease of use; effectiveness
29	Gutiérrez-Puertas et al [52], 2021, Spain	Nursing (N=184)	Randomized controlled trial: questionnaire; task and knowledge performance	Learning performance; satisfaction
30	Herbert et al [53], 2021, United States	Nursing (N=33)	Randomized controlled trial: questionnaire; task and knowledge performance	Ease of use; learning performance; navigation; operational usability; usefulness
31	Hsu et al [54], 2019, Taiwan	Nursing (N=16)	Qualitative methods: interviews	Context of use; operational usability; satisfaction; usefulness
32	Huang et al [55], 2010, Taiwan	Not clear (N=28)	Posttest 1-group design: questionnaire	Ease of use; satisfaction, usefulness
33	Hughes and Kearney [56], 2017, United States	Occupational therapy (N=19)	Qualitative methods: focus groups	Efficiency; satisfaction
34	Ismail et al [57], 2018, Malaysia	Health science (N=124)	Pre-post test, 1-group design: questionnaire	Ease of use; learning performance; satisfaction; user-friendliness
35	Johnson et al [58], 2021, Norway	Occupational therapy, physiotherapy, and social education (N=15)	Qualitative methods: focus groups	Context of use; ease of use; operational usability
36A	Kang Suh [59], 2018, South Korea	Nursing (N=92)	Pre-post test, nonrandomized control group design: questionnaire; data from app	Effectiveness; frequency of use; learning performance; satisfaction
36B	Kang Suh [59], 2018, South Korea	Nursing (N=49)	Qualitative methods: focus groups	Effectiveness; frequency of use; learning performance; satisfaction
37	Keegan et al [60], 2016, United States	Nursing (N=116)	Posttest nonrandomized control group design: questionnaire; task and knowledge performance	Learning performance; satisfaction; usefulness

Study number	Study	Population (N)	Research design: data collection method	Usability attributes
38	Kim-Berman et al [61], 2019, United States	Dentist (N=93)	Posttest 1-group design: questionnaire; task and knowledge performance	Context of use; ease of use; effectiveness; usefulness
39	Kojima et al [62], 2011, Japan	Physiotherapy and occupational therapy (N=41)	Pre-post test, 1-group design: questionnaire	Ease of use; learning performance; satisfaction; usefulness
40	Koulias et al [63], 2012, Australia	Medicine (N=171)	Posttest 1-group design: questionnaire	Ease of use; operational usability; satisfaction
41	Kow et al [64], 2016, Singapore	Medicine (N=221)	Pre-post test, 1-group design: questionnaire	Learning performance; satisfaction
42	Kurniawan and Witjaksono [65], 2018, Indonesia	Medicine (N=30)	Posttest 1-group design: questionnaire	Satisfaction; usefulness
43A	Lefroy et al [66], 2017, United Kingdom	Medicine (N=21)	Qualitative methods: focus groups; data from app	Context of use; frequency of use; satisfaction
43B	Lefroy et al [66], 2017, United Kingdom	Medicine (N=405)	Quantitative methods: data from app	Context of use; frequency of use; satisfaction
44	Li et al [67], 2019, Taiwan	Health care (N=70)	Pre-post test, nonrandomized control group design: questionnaire[b]	Ease of use; usefulness
45	Lin and Lin [68], 2016, Taiwan	Nursing (N=36)	Pre-post test, nonrandomized control group design: questionnaire	Cognitive load; ease of use; learnability; learning performance; usefulness
46	Lone et al [69], 2019, Ireland	Dentist (N=59)	Randomized controlled trial: questionnaire; task and knowledge performance	Ease of use; learnability; learning performance; operational usability; satisfaction
47A	Long et al [70], 2016, United States	Nursing (N=158)	Pre-post test, 1-group design: questionnaire; data from app	Ease of use; efficiency; learnability; learning performance; satisfaction
47B	Long et al [70], 2016, United States	Health science (N=159)	Randomized controlled trial: questionnaire; data from app	Ease of use; efficiency; learnability; learning performance; satisfaction
48	Longmuir [71], 2014, United States	Medicine (N=56)	Posttest 1-group design: questionnaire; data from app	Efficiency; learnability; operational usability; satisfaction
49	López et al [72], 2016, Spain	Medicine (N=67)	Posttest 1-group design: questionnaire[b]	Context of use; ease of use; errors; satisfaction; usefulness
50	Lozano-Lozano et al [73], 2020, Spain	Physiotherapy (N=110)	Randomized controlled trial: questionnaire; task and knowledge performance	Learning performance; satisfaction; usefulness
51	Lucas et al [74], 2019, Australia	Pharmacy (N=39)	Pre-post test, 1-group design: questionnaire; task and knowledge performance	Satisfaction; usefulness
52	Mathew et al [75], 2014, Canada	Medicine (N=5)	Think-aloud methods: questionnaire[b]; interviews; task and knowledge performance	Learnability; satisfaction
53	McClure [76], 2019, United States	Nursing (N=16)	Posttest 1-group design: questionnaire[b]	Learnability; satisfaction; usefulness
54	McDonald et al [77], 2018, Canada	Medicine (N=20)	Pre-post test, 1-group design: questionnaire; data from app	Effectiveness; satisfaction
55	McLean et al [78], 2014, Australia	Medicine (N=58)	Mixed methods: questionnaire; focus groups; interviews	Satisfaction
56	McMullan [79], 2018, United Kingdom	Health science (N=60)	Pre-post test, 1-group design: questionnaire	Learning performance; navigation; satisfaction; usefulness; user-friendliness

Study number	Study	Population (N)	Research design: data collection method	Usability attributes
57	Mendez-Lopez et al [80], 2021, Spain	Psychology (N=67)	Pre-post test, 1-group design: questionnaire; task and knowledge performance	Cognitive load; ease of use; learning performance; satisfaction; usefulness
58	Meruvia-Pastor et al [81], 2016, Canada	Nursing (N=10)	Pre-post test, 1-group design: questionnaire; task and knowledge performance	Ease of use; learning performance; satisfaction; usefulness
59	Mettiäinen [82], 2015, Finland	Nursing (N=121)	Mixed methods: questionnaire; focus groups	Ease of use; usefulness
60	Milner et al [83], 2020, United States	Medicine and nursing (N=66)	Posttest 1-group design: questionnaire	Satisfaction; usefulness
61	Mladenovic et al [84], 2021, Serbia	Dentist (N=56)	Posttest 1-group design: questionnaire	Context of use; ease of use; satisfaction; usefulness
62	Morris and Maynard [85], 2010, United Kingdom	Physiotherapy and nursing (N=19)	Pre-post test, 1-group design: questionnaire	Context of use; ease of use; navigation; operational usability; usefulness
63A	Nabhani et al [86], 2020, United Kingdom	Pharmacy (N=56)	Posttest 1-group design: questionnaire	Ease of use; learnability; learning performance; satisfaction; usefulness
63B	Nabhani et al [86], 2020, United Kingdom	Pharmacy (N=152)	Posttest 1-group design: questionnaire	Ease of use; learnability; learning performance; satisfaction; usefulness
63C	Nabhani et al [86], 2020, United Kingdom	Pharmacy (N=33)	Posttest 1-group design: task and knowledge performance	Ease of use; learnability; learning performance; satisfaction; usefulness
64A	Noguera et al [87], 2013, Spain	Physiotherapy (N=84)	Posttest 1-group design: questionnaire	Learning performance; satisfaction; usefulness
64B	Noguera et al [87], 2013, Spain	Physiotherapy (N=76)	Randomized controlled trial: questionnaire	Learning performance; satisfaction; usefulness
65	O’Connell et al [88], 2016, Ireland	Medicine, nursing, and pharmacy (N=89)	Randomized controlled trial: questionnaire[b]	Ease of use; learning performance; operational usability; satisfaction; simplicity
66	Oliveira et al [89], 2019, Brazil	Medicine (N=110)	Randomized controlled trial: questionnaire; task and knowledge performance	Frequency of use; learning performance; satisfaction
67	Orjuela et al [90], 2015, Colombia	Medicine (N=22)	Posttest 1-group design: questionnaire	Ease of use; satisfaction
68	Page et al [91], 2016, United States	Medicine (N=356)	Mixed methods: questionnaire; interviews	Context of use; efficiency; satisfaction
69	Paradis et al [92], 2018, Canada	Medicine and nursing (N=108)	Posttest 1-group design: questionnaire[b]	Ease of use; satisfaction; usefulness
70	Pereira et al [93], 2017, Brazil	Medicine (N=20)	Posttest 1-group design: questionnaire[b]	Ease of use; learnability; satisfaction; usefulness
71	Pereira et al [94], 2019, Brazil	Nursing (N=60)	Posttest 1-group design: questionnaire	Ease of use; operational usability; satisfaction
72A	Pinto et al [95], 2008, Brazil	Biomedical informatics (N=5)	Qualitative methods: observations; task and knowledge performance	Efficiency; errors; learnability; learning performance; operational usability; satisfaction
72B	Pinto et al [95], 2008, Brazil	Medicine (N=not clear)	Posttest nonrandomized control group design: questionnaire	Efficiency; errors; learnability; learning performance; operational usability; satisfaction

Study number	Study	Population (N)	Research design: data collection method	Usability attributes
73	Quattromani et al [96], 2018, United States	Nursing (N=181)	Randomized controlled trial: questionnaire[b]	Learnability; learning performance; satisfaction; usefulness
74	Robertson and Fowler [97], 2017, United States	Medicine (N=18)	Qualitative methods: focus groups	Satisfaction
75A	Romero et al [98], 2021, Germany	Medicine (N=22)	Think-aloud methods: questionnaire; interviews; task and knowledge performance	Effectiveness; efficiency; errors; navigation; satisfaction
75B	Romero et al [98], 2021, Germany	Medicine (N=22)	Posttest 1-group design: questionnaire[b]	Learnability; satisfaction
75C	Romero et al [98], 2021, Germany	Medicine (N=736)	Posttest 1-group design: questionnaire	Frequency of use; satisfaction
76	Salem et al [99], 2020, Australia	Pharmacy (N=33)	Posttest 1-group design: questionnaire	Operational usability; satisfaction; usefulness
77	San Martín-Rodríguezet al [100], 2020, Spain	Nursing (N=77)	Posttest 1-group design: questionnaire; task and knowledge performance	Learning performance; operational usability; satisfaction
78	Schnepp and Rogers [101], 2017, United States	Not clear (N=72)	Think-aloud methods: questionnaire[b]; interviews; task and knowledge performance	Learnability; satisfaction
79	Smith et al [102], 2016, United Kingdom	Medicine and nursing (N=74)	Mixed methods: questionnaire; focus groups	Navigation; operational usability; satisfaction; user-friendliness
80	Strandell-Laine et al [103], 2019, Finland	Nursing (N=52)	Mixed methods: questionnaire[b]; written qualitative responses	Learnability; operational usability; satisfaction
81	Strayer et al [104], 2010, United States	Medicine (N=122)	Mixed methods: questionnaire; focus groups	Context of use; learnability; learning performance; satisfaction; usefulness
82	Taylor et al [105], 2010, United Kingdom	A total of 8 different health care educations (N=79)	Qualitative methods: focus groups; written qualitative reflections	Context of use; learnability
83	Toh et al [106], 2014, Singapore	Pharmacy (N=31)	Posttest 1-group design: questionnaire	Ease of use; learnability; navigation; usefulness
84	Tsopra et al [107], 2020, France	Medicine (N=57)	Mixed methods: questionnaire; focus groups	Ease of use; operational usability; satisfaction; usefulness
85	Wu [108], 2014, Taiwan	Nursing (N=36)	Mixed methods: questionnaire; interviews	Cognitive load; effectiveness; satisfaction; usefulness
86	Wyatt et al [109], 2012, United States	Nursing (N=12)	Qualitative methods: focus groups	Ease of use; efficiency; errors; learnability; memorability; navigation; satisfaction
87	Yap [110], 2017, Singapore	Pharmacy (N=123)	Posttest 1-group design: questionnaire	Comprehensibility; learning performance; memorability; navigation; satisfaction; usefulness
88	Zhang et al [111], 2015, Singapore	Medicine (N=185)	Mixed methods: questionnaire; focus groups	Usefulness

[a]Performances measured, comparing paper and app results, quiz results, and exam results.

[b]Reported use of validated questionnaires.

Usability Evaluation Methods

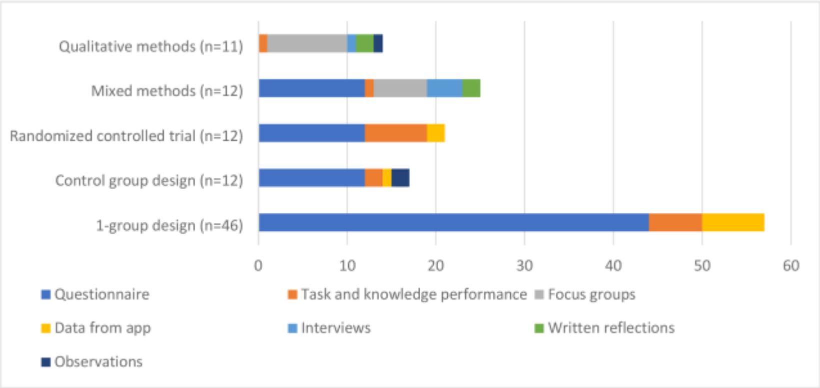
The usability evaluation methods found were either inquiry-based or based on user testing. The following inquiry methods were used: 1-group design (46/98, 47%), control group design (12/98, 12%), randomized controlled trials (12/98, 12%), mixed methods (12/98, 12%), and qualitative methods (11/98, 11%). Several studies that applied inquiry-based methods used more than one data collection method, with questionnaires being used most often (80/98, 82%), followed by task and knowledge performance testing (17/98, 17%), focus groups (15/98, 15%), collection of user data from the app (10/98, 10%), interviews (5/98, 5%), written qualitative reflections (4/98, 4%), and observations (3/98, 3%). Additional information can be found in the data extraction sheet (Multimedia Appendix 3). Figure 2 illustrates the frequency of the inquiry-based usability evaluation methods and data collection methods.

The only user testing methods found were think-aloud methods (5/98, 5%), and 4 (80%) of these studies applied more than one data collection method. The data collection methods used included interviews (4/98, 4%), questionnaires (3/98, 3%), task and knowledge performance (3/98, 3%), focus groups (1/98, 1%), and collection of user data from the app (1/98, 1%).

A total of 19 studies used a psychometrically tested usability questionnaire, including the SUS, Technology Acceptance Model, Technology Satisfaction Questionnaire, and Technology Readiness Index. SUS [112] was used in most (9/98, 9%) of the studies.

Field testing was the most frequent type of usability experiment, accounting for 72% (71/98) of usability experiments. A total of 22 (22%) studies performed laboratory testing, and 5 (5%) studies did not indicate the type of experiment performed. Multimedia Appendix 3 provides an overview of the type of experiment conducted in each study. The usability testing of the mobile apps took place in a classroom setting (41/98, 42%), in clinical placement (29/98, 30%), during simulation training (14/98, 14%), other (7/98, 7%), or the setting was not specified (5/98, 5%).

Figure 2. Inquiry usability evaluation methods and data collection methods.



Usability Attributes

A total of 17 usability attributes have been identified among the included studies. The most frequently identified attributes were satisfaction, usefulness, ease of use, learning performance, and learnability. The least frequent were errors, cognitive load, comprehensibility, memorability, and simplicity. Table 3 provides an overview of the usability attributes identified in the included studies.

Table 3. Distribution of usability attributes (n=17) and affiliated reports (N=88).

Usability attribute	Distribution, n (%)	Reports (references)
Satisfaction	74 (84)	[24-28,31-37,39-42,44-48,50,52,54-57,59,60,62-66,69-81,83,84,86-104,107-110]
Usefulness	51 (58)	[24,26,28-31,35-39,42-47,49,50,53-55,60-62,65,67,68,72-74,76,79-87,92,93,96,99,104,106-108,110,111]
Ease of use	45 (51)	[24,26,28,29,31,32,35-38,41-43,45-47,49-51,53,55,57,58,61-63,67-70,72,80-82,84-86,88,90,92-94,106,107,109]
Learning performance	33 (38)	[24,32-34,36,37,41,42,48,49,52,53,57,59,60,62,64,68-70,73,79-81,86-89,95,96,100,104,110]
Learnability	23 (26)	[28,33,35,40,41,44,68-71,75,76,86,93,95,96,98,101,103-106,109]
Operational usability	19 (22)	[42,45,50,53,54,58,63,69,71,85,88,90,94,95,99-101,103,107]
Context of use	14 (16)	[30,35,38,44,54,58,61,66,72,84,85,91,104,105]
Navigation	12 (14)	[31,40-42,53,79,85,98,102,106,109,110]
Efficiency	11 (13)	[30,39,40,46,56,70,71,91,95,98,109]
Effectiveness	10 (11)	[32,39-41,51,59,61,77,98,108]
Frequency of use	10 (11)	[26,31,38,42,47,49,59,66,89,98]
User-friendliness	7 (8)	[29,37,40,45,57,79,102]
Errors	5 (6)	[42,72,95,98,109]
Cognitive load	3 (3)	[68,80,108]
Comprehensibility	2 (2)	[43,110]
Memorability	2 (2)	[109,110]
Simplicity	2 (2)	[31,88]

Discussion

Principal Findings

This scoping review sought to identify the usability methods and attributes reported in usability studies of mobile apps for health care education. A total of 88 articles, with a total of 98 studies reported in these 88 articles, were included in this review. Our findings indicate a steady increase in publications from 2014, with studies being published in 22 different countries. Field testing was used more frequently than laboratory testing. Furthermore, the usability evaluation methods applied were either inquiry-based or based on user testing. Most of the inquiry-based methods were experiments that used questionnaires as a data collection method, and all of the studies with user testing methods applied think-aloud methods. Satisfaction, usefulness, ease of use, learning performance, and learnability were the most frequently identified usability attributes.

Comparison With Prior Work

Usability Evaluation Methods

The studies included in this scoping review mainly applied inquiry-based methods, primarily the collection of self-reported data through questionnaires. This is congruent with the results of Weichbroth [10], in which controlled observations and surveys were the most frequently applied methods. Asking users to respond to a usability questionnaire may provide relevant and valuable information. Among the 83 studies that used questionnaires in our review, only 19 (23%) used a psychometrically tested usability questionnaire; of these, the SUS questionnaire [112] was used most frequently. In line with the review on usability questionnaires [12], we recommend using a psychometrically tested usability questionnaire to support the advancement of usability science. As questionnaires address only certain usability attributes, mainly learnability, efficiency, and satisfaction [12], it would be helpful to also include additional methods, such as interviews or mixed methods, and to incorporate additional open-ended questions when using questionnaires.

Furthermore, the application of usability evaluation methods other than inquiry methods, such as user testing methods and inspection methods [10], could be beneficial and lead to more objective measures of app usability. Among other things, subjective data are collected via self-reported questionnaires, and objective data are collected based on task completion rates [40]. For example, in one of the included studies, the participants reported that the usability of the app was satisfactory by subjective measures, but the participants did not use the app [75]. Another study reported a lack of coherence between subjective and objective data; thus, these results indicate the importance of not relying solely on subjective measures of usability [40]. Therefore, it is suggested that various usability evaluation methods, including subjective and objective usability measures, are used in future usability studies.

Our review found that most of the included studies in health care education (71/98, 72%) performed field testing, whereas previous literature suggests that usability experiments in other fields are more often conducted in a laboratory [1,113]. For instance, Kumar and Mohite [1] found that 73% of the studies included in their review of mobile learning apps used laboratory testing. Mobile apps in health care education have been developed to support students' learning, on-campus and during clinical placement, in various settings and on the move. Accordingly, it is especially important to test how the apps are perceived in specific environments [5]; hence, field testing is required. However, many usability issues can be discovered in a laboratory. Particularly in the early phases of app development, testing an app with several participants in a laboratory may make it more feasible to test and improve the app [8]. Usability testing in a laboratory can provide rapid feedback on usability issues, which can then be addressed before testing the app in a real-world environment. Therefore, it may be beneficial to conduct small-scale laboratory testing before field testing.

Usability Attributes

Previous systematic reviews of mobile apps in general identified satisfaction, efficiency, and effectiveness as the most common usability attributes [5,10]. In this review, efficiency and effectiveness were explored to a limited extent, whereas satisfaction, usefulness, and ease of use were the most frequently identified usability attributes. Our results coincide with those from a previous review on the usability of mobile learning apps [1], possibly because satisfaction, usefulness, and ease of use are usability attributes of particular importance when examining mobile learning apps.

Learning performance was assessed frequently in the included studies. For ensuring that apps are valuable in a given learning context, it is relevant to test additional usability attributes such as cognitive load [9]. However, few studies included in our review examined cognitive load [68,80,108]. Mobile apps are often used in an environment with multiple distractions, which may contribute to an increased cognitive load [5], affecting the learning performance. Testing both learning performance and app users' cognitive load may improve the understanding of the app's usability.

We found that several of the included studies did not use terminology from usability literature to describe which usability attributes they were testing. For instance, studies that tested satisfaction often used words such as "likes and dislikes" and "recommend use to others" and did not specify that they tested the usability attribute satisfaction. Specifying which usability attributes are investigated will be important when performing a usability study of mobile apps, as this will influence transparency and enable comparison between different studies. In addition, evaluating a wider range of usability attributes may enable researchers to expand their perspective regarding the app's usability problems and ensure quicker improvement of the app. Defining and presenting different usability attributes in a reporting guideline can assist in deciding on and reporting relevant usability attributes. As such, a reporting guideline would be beneficial for researchers planning and conducting usability studies, a point that is also supported by the systematic review conducted by Kumar and Mohite [1].

Future Directions

Combining different usability evaluation methods that incorporate both subjective and objective usability measures can add various and important perspectives when developing apps. In future studies, it would be advantageous to use psychometrically tested usability questionnaires to support the advancement of the usability science. In addition, developers of mobile apps should determine which usability attributes are relevant before conducting usability studies (eg, by registering a protocol). Incorporating these perspectives into the development of a reporting guideline would be beneficial to future usability studies.

Strengths and Limitations

First, the search strategy was designed in collaboration with a research librarian and peer reviewed by another research librarian and included 10 databases and other sources. This broad search strategy resulted in a high number of references, which may be associated with a lower level of precision. To ensure the retrieval of all potentially pertinent articles, two of the authors independently screened titles and abstracts; studies deemed eligible by one of the authors were included for full-text screening.

Second, the full-text evaluation was challenging because the term *usability* has multiple meanings that do not always relate to usability testing. For instance, the term was used when testing students' experience of a commercially developed app but not in connection with the app's further development. In addition, many studies did not explicitly state that a mobile app was being investigated, which also created a challenge when deciding whether they satisfied the eligibility criteria. Nevertheless, reading the full-text articles independently by 2 reviewers and solving disagreements through consensus-based discussions ensured the inclusion of relevant articles.

Conclusions

This scoping review was performed to provide an overview of the usability methods used and the attributes identified in usability studies of mobile apps in health care education. Experimental designs were commonly used to evaluate usability and most studies used field testing. Questionnaires were frequently used for data collection, although few studies used psychometrically tested questionnaires. Usability attributes identified most often were satisfaction, usefulness, and ease of use. The results indicate that combining different usability evaluation methods, incorporating both subjective and objective usability measures, and specifying which usability attributes to test seem advantageous. The results can support the planning and conduct of future usability studies of the advancement of learning apps in health care education.

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Authors' Contributions

SGJ, LL, DC, and NRO proposed the idea for this review. SGJ, DC, and NRO contributed to the screening of titles and abstracts, and SGJ and TP decided on eligibility based on full-text examinations. SGJ extracted data from the included studies. SGJ, TP, LL, DC, and NRO contributed to the drafts of the manuscript, and all authors approved the final version for publication.

Conflicts of Interest

None declared.

Multimedia Appendix 1

PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist for reporting scoping reviews.
[DOCX File , 107 KB-Multimedia Appendix 1]

Multimedia Appendix 2

The search strategies for the 10 databases.
[DOCX File , 84 KB-Multimedia Appendix 2]

Multimedia Appendix 3

Data extraction sheet.
[XLSX File (Microsoft Excel File), 156 KB-Multimedia Appendix 3]

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Abbreviations

PRISMA-ScR: Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews
SUS: System Usability Scale

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Appendices

Appendix 1: Interview guide (Paper I)

Appendix 2: The scoring plan of the *EBPsteps* (Paper II)

Appendix 3: Protocol for the scoping review (Paper III)

Appendix 4: NSD Approval (Papers I–II)

Appendix 5: Sikt Approval (Papers I–II)

Appendix 6: Consent form (Paper I)

INTERVJUGUIDE: BRUK AV EN MOBILAPPLIKASJON FOR Å FREMME KUNNSKAPSBASERT PRAKSIS BLANT HELSE- OG SOSIALFAGSTUDENTER

INTRODUKSJON (starter intervju med å lese høyt to første avsnitt her)
I henhold til nasjonale føringer bør opplæring i kunnskapshåndtering og kunnskapsbasert praksis (KBP) være obligatorisk i alle helsefagutdanningene. Fokuset for denne samtalen er deres erfaringer med bruk av en mobilapplikasjon/app, spesielt designet for å støtte prosessen med KBP, inkludert trinnene i KBP.

Vi ønsker å finne ut hva som må jobbes videre med. Vi er interessert i hva som fungerer, i tillegg til hvordan en slik app kan bli bedre. Målet er å finne ut hva som skal til for å optimalisere den tekniske løsningen, samt innhold og funksjoner i appen. Vi vil derfor utforske hvordan dere erfarte og opplevde bruk av appen, for eksempel hva fungerte og hva fungerte ikke, som alt fra det tekniske til flyt, lagring og sending, samt om dere opplevede om det var lett eller vanskelig å forstå hva dere måtte gjøre for å fylle ut appen. Dere må gjerne sammenligne med erfaringer fra andre app'er.

Før vi starter selve intervjuet vil vi be studentene om å gå innom deres egen app/profil for å få en oppfriskning mht hva de har brukt appen til. Vi tar frem appen og viser på PC/skjerm dersom de ikke får det til.

TEMASPØRSMÅL (underpunkter etterspørres dersom de ikke kommer opp naturlig i samtalen)

Hvordan opplevde dere utforming av appen (funksjon/teknisk)?

- Hva var førsteinntrykk av appen? Intuitivt hvordan den skulle brukes? (grensensnitt, ikoner)
- Hvor lett var den å bruke, første gang dere brukte appen? Tok det tid å forstå hvordan den skulle brukes? ("Learnability")
- Var innholdet gjenkjennbart? (KBP, trinnene kjent)
- Hva likte dere med appen? Hvorfor? Hvor godt likte dere designet? («Satisfaction»)
- Var det noe dere ikke likte (ville ha forbedret) med appen? Hvorfor?
- Hvordan var det å fylle ut spørsmålene (lett/vanskelig, og likt neste gang)? (manipulation)
- Hvor raskt lærte dere å bruke appen, å utføre oppgavene/spørsmålene i appen («efficiency»)
- Når du tok frem appen etter en stund, hvordan var det å huske innholdet i appen? («memorability»)
- Gjør dere mye feil og klarer dere å rette opp i feil? («errors»)
- Er det spørsmålsformulering/begreper/uttrykk/svaralternativer dere ikke forstår?
- Hvordan var det å flytte seg fra spørsmål til spørsmål (lett/vanskelig)? (navigation)
- Hvor lett / vanskelig var det å forstå at det du skrev ble lagret automatisk underveis?
- Fant dere sendefunksjon, kalkulator, ordliste?

Kan dere beskrive situasjoner der dere brukte eller vurderte å bruke appen i praksis?

- Hvorfor valgte dere å bruke/ikke bruke appen?
- Utfordringer?
- Opplevde dere behov for veiledning i bruk av appen underveis? Fikk dere veiledning? Av hvem?
- Hvordan ble appen brukt (fylte ut alle trinn/deler, for å lære, for å dokumentere praksis osv.)?
- Har dere brukt appen for flere ulike spørsmål (PICO)?
- Har dere jobbet kunnskapsbasert uten appen?
- Påminnelse til oss: for eksempel om student sier «vi kritisk vurderte» - spør hvordan de gjorde

dette.

Kan dere beskrive erfaringer med appen i praksis?

- Utfordringer?
- På hvilken måte var den nyttig?
- Fylte dere ut alle trinnene for hvert spørsmål (PICO)? Hvorfor ikke?
- Har dere lært noe om KBP gjennom å bruke appen i praksis?
- Fikk dere utført det dere skulle når dere brukte appen? (Evt. fant dere informasjonen dere trengte?)
- Brukte dere appen på praksisplassen/hjemme/andre steder? På telefon? På PC?
- Hva skal til for at dere anvender appen i fremtidig arbeid?

Kan dere beskrive erfaringer med undervisning/introduksjon til appen?

- Kort minne studentene på hva som ble gjort av undervisning/introduksjon (ved behov).
- Hva var bra/mindre bra/kan bli bedre?

Kan dere beskrive erfaringer med arbeidskrav (radiografi)/presentasjon av appen og eksamen (ergoterapi)/lesesirkel og krav å legge frem begrunnelse for søk/resultat av søk for praksisplassen (vernepleie)

- Hva var bra/mindre bra/kan bli bedre?

AVSLUTNING

Har dere noe dere vil tilføye?

The scoring plan of the *EBPsteps* (Paper II)

EBP steps	What was assessed?	Descriptions for the assessments	Values given for data analysis
Ask	Was it reflected on the information needs?	Assessed as correct when a need for more knowledge on a clinical problem was presented.	1
		Assessed as incorrect when only keywords were presented.	2
		Missing	99 ***
	Which clinical question was formulated?	Prevalence (How many have a health problem?)	1
		Cause-aetiology (Why do some people get this problem while others stay healthy?)	2
		Diagnostics (How can we determine if someone has this problem?)	3
		Effect of measures (What can be done to prevent or treat the problem?)	4
		Prognosis (How is the person with the problem?)	5
		Experiences and attitudes (How are it experienced? What makes it work?)	6
		Background question, for example: "How to use HABIT in work with children with spastic hemiplegia?" Used question words such as how or which.	66 ***
		Assessed as not completed/incomplete when nothing was written or only keywords were provided; it had to be written as a question.	99 ***
	Which clinical question was identified (drop-down menu)?	Prevalence	1
		Cause – aetiology	2
		Diagnostics	3
		Effect of measures	4
		Prognosis	5
		Experiences and attitudes	6
		Missing/not identified	99 ***
	Was there an agreement between the formulated clinical question and the type of question identified from the drop-down menu?	Assessed as correct if there was an agreement between the formulated clinical question and the type of question identified from a drop-down menu (e.g. the formulated clinical question was a question of effect, and the question from the drop-down menu was identified as an effect question).	1
		Assessed as incorrect if there was no agreement between the formulated clinical question and the type of question identified from a drop-down menu.	2
		It could not be assessed if a background question was written or a clinical question was not written.	77 ***
		It was not completed if a research question was not identified from the drop-down menu.	99 ***
	Was the Population of the PICO*/PICo**correctly reported?	Assessed as correct when the Population was related to the type of population and problem area (e.g. elderly with dementia), and/or a problem area (e.g. dementia), and nothing else (e.g. intervention). Different terms/synonyms for the same theme (e.g. dementia and Alzheimer's) approved.	1
		Assessed as incorrect if other PICO*/PICo** elements were included. Only age (e.g. elderly) was not sufficient.	2
		Missing	99 ***
	Was the	Assessed as correct when it was about the	1

	Intervention/Interest of the PICO*/PICo** correctly reported?	Intervention/Interest and nothing else.	
		Assessed as incorrect if other PICO*/PICo** elements were included.	2
		Not completed	99 ***
	Was the Comparison of the PICO*/PICo** correctly reported?	Assessed as correct when it was about the Comparison and nothing else.	1
		Assessed as incorrect if other PICO*/PICo** elements were included.	2
		Not relevant for prevalence, cause, prognosis, and experience questions.	88
		Missing	99 ***
	Was the Outcome/Context of the PICO*/PICo** correctly reported?	Assessed as correct when it was about the Outcome/Context and nothing else. Included a clear outcome, e.g. ADL function, participation in work, or pain.	1
		Assessed as incorrect if other PICO*/PICo** elements were included. Only "effect" was not sufficient as an outcome.	2
		Missing	99 ***
Access	Which information sources were used?	BMJ Best Practice	1
		UpToDate	2
		Fagprosedyrer.no	3
		National Guideline Clearinghouse	4
		Campbell Library	5
		Cochrane Library	6
		Epistemonikos	7
		Health Evidence	8
		The Norwegian Health Library search field	9
		Joanna Briggs Institute EBP	10
		Otseeker	11
		PEDro	12
		AMED	13
		CINAHL	14
		Embase	15
		MEDLINE	16
		PubMed	17
		PsycINFO	18
		SveMed+	19
		Other	20
		Missing	99 ***
	Was a link to research evidence reported?	Assessed as correct if a research article was included.	1
		Assessed as incorrect if a report, letter, or similar was included or the research evidence was not included.	2
	Was there an agreement between the information source used and the identified research evidence?	Assessed as correct if there was an agreement between the choice of information source and chosen research article. For instance, qualitative questions could be found in Cinahl, Medline, PsycINFO, and/or other general databases.	1
		Assessed as incorrect if there was no agreement.	2
		It could not be assessed if a background question was formulated.	77 ***
		Missing	99 ***
Appraise	Was there an agreement between the identified research evidence and the chosen critical appraisal checklist used?	Assessed as correct when there was an agreement between the research article and checklist, they included the same study design.	1
		Assessed as incorrect if there were no agreements.	2
		It could not be assessed because an article or checklist was not chosen.	77 ***
	Were the questions in the	Each question in the checklist was assessed individually as	1

	checklist completed?	correct when completed.	
		Each question in the checklist was assessed individually as incorrect when missing.	2
Apply	Was the application of the research evidence reported (drop-down menu)?	Yes	1
		No	2
	If reported applied, was this described?	Assessed as correct if applying the evidence in practice was reported.	1
		Assessed as incorrect if it was not described how the research was applied.	2
		Missing	99 ***
Audit	Were changes in practice evaluated?	Assessed as correct if changes in practice were evaluated.	1
		Assesses as incorrect when changes in practice were not evaluated or the reporting of 'not relevant'.	2
		Assessed when reported 'did not change practice'.	55 ***
		Missing	99 ***
	Was the EBP process evaluated?	Assessed as correct when reflection was mentioned of one or more steps.	1
		Assessed as incorrect when no reflection of the steps was mentioned.	2
		Missing	99 ***

* PICO (Abbreviation for Population, Intervention, Comparison, and Outcome).
** PICo (Abbreviation for Population, Interest, and Context).
*** These categories were given the value 2 (incorrect) for the analyses in SPSS.

Protocol

Usability Methods and Attributes Reported in Usability Studies of Mobile Apps for Health Care Education: Protocol for a Scoping Review

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Abstract

Background: E-learning technologies, including mobile apps, are used to a large extent in health care education. Mobile apps can provide extendable learning environments and motivate students for adaptive and collaborative learning outside the classroom context. Developers should design practical, effective, and easy-to-use mobile apps. Usability testing is an important part of app development in order to understand if apps meet the needs of users.

Objective: The aim of this study is to perform a scoping review of usability methods and attributes reported in usability studies of mobile apps for health care education.

Methods: The scoping review is guided by the methodological framework developed by Arksey & O'Malley and further developed by Levac et al and Kahlil et al. The stages we will follow are as follows: (1) identifying the research question; (2) identifying relevant studies; (3) selecting studies; (4) charting the data; and (5) summarizing and reporting the results. We have developed two research questions to meet the aim of the study, which are as follows: (1) What usability methods are used to evaluate the usability of mobile apps for health care education? and (2) What usability attributes are reported in the usability studies of mobile apps for health care education? We will apply a comprehensive search of the literature, including 10 databases, a reference search, and a search for grey literature. Two review authors will independently screen articles for eligibility.

Results: The initial electronic database searches were completed in March 2019. The literature search identified 14,297 unique references. Following title and abstract screening, the full texts of 369 records were obtained. The scoping review is expected to be completed in spring 2021.

Conclusions: We expect the overview of usability methods and attributes reported in usability studies of mobile apps for health care education to contribute to the knowledge base for researchers and developers. It will give an overview of the research field and provide researchers and developers with relevant and important information on the usability research area, including highlighting possible research gaps.

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KEYWORDS
user-computer interface; mobile app; online learning; health education; students

Introduction

Background

There has been increasing attention for e-learning technologies, including mobile apps, in health care education. Mobile apps can provide extendable learning environments and motivate students for adaptive and collaborative learning outside the classroom context [1,2]. However, mobile apps have small screen sizes and connectivity problems, and the context provides distractions for the user [3]. Developers of mobile apps need to ensure that apps are practical, effective, and easy to use [1]. Usability testing is important in app development in order to understand how mobile apps meet the needs of users [4]. According to the International Organization for Standardization (ISO), usability is defined as "The extent to which a system, product, or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [5].

Usability Methods

Usability methods, which are currently referred to in usability studies, involve laboratory experiments and field studies [1,6]. There are advantages and disadvantages for both methods. Laboratory experiments take place in a usability laboratory, where the test procedure is conducted in a controlled environment. In a laboratory, researchers can record user activity while they fulfil predefined tasks for later analysis [6], and they can control other irrelevant variables [3]. It is however not possible to test real-world problems (eg, only brief episodes of available time during clinical placement) or problems with internet connection. The expense of instruments and dedicated space make laboratory experiments more costly than other methods [6]. Field studies involve the collection of real-time data from users performing tasks in the real-world environment. In field studies, data about task flows, inefficiencies, and the organizational and physical environments are collected [6]. Field studies allow for data collection within the dynamic nature of the context, which is almost impossible to simulate in a laboratory experiment [1]. However, as users move around in field studies, data collection and conditions are difficult to control [1]. It can also be challenging to collect data in a precise and timely manner [7].

Usability Attributes

Usability attributes are features used to measure the quality of mobile apps [1]. The three most common usability attributes are effectiveness, efficiency, and satisfaction [3], and all three are part of the ISO standard for usability [5]. Other attributes are learnability, memorability, errors, simplicity, comprehensibility, and learning performance [7]. Selecting appropriate usability attributes depends on the nature of the e-learning technology and the research question of the usability study [7]. It is unclear which usability attributes are most relevant to mobile apps for health care students, although Sandars [8] highlighted the following four main domains for usability testing of e-learning: the learner, technological aspects (navigation, learnability, accessibility, consistency, and visual design), instructional design aspects (interactivity, content and resources, media use, and learning strategy design), and the context.

Previous reviews on usability methods examined usability testing in general [9] or usability specifically related to mobile apps [3,6,7,10]. Only one systematic review specifically explored the usability of mobile learning apps [1], although it did not include studies from health care education. Thus, there is a need for an overview of studies reporting on usability evaluations of mobile apps related to health care education. The aim of this study is to perform a scoping review of usability methods and attributes reported in usability studies of mobile apps for health care education.

Methods

Overview

A scoping review summarizes and disseminates research findings to describe the breadth and range of research in a particular topic or field [11-13]. To address the objectives of this scoping review, we will follow the framework for scoping reviews developed by Arksey & O'Malley [11], which was further developed by Levac et al [12] and Kahlil et al [13]. We will adopt the following five stages of this framework: (1) identifying the research question; (2) identifying relevant studies; (3) selecting studies; (4) charting the data; and (5) summarizing and reporting the results [11-13]. A detailed presentation of each step is provided below. This scoping review will also follow the PRISMA-ScR checklist for reporting scoping reviews [14].

Stage 1: Identifying the Research Question

Research questions in a scoping review are broad and have a goal to summarize the breadth of the evidence, although the research questions should include a clear scope of inquiry [12]. We have developed two research questions to meet the aim of the study, which are as follows: (1) What usability methods are used to evaluate the usability of mobile apps for health care education? and (2) What usability attributes are reported in usability studies of mobile apps for health care education?

Stage 2: Literature Search (Identifying Relevant Studies)

The term usability is defined and used in multiple ways, making it hard to develop a comprehensive search strategy for the term. Using a broader search may be preferable [15]. Therefore, the sensitivity (finding as many relevant articles as possible) of the search is prioritized over the specificity (making sure retrieved articles are relevant), as recommended in order not to miss any relevant articles [16].

We will search the following 10 electronic databases covering technology, education, and health care: Engineering Village (Elsevier), Scopus (Elsevier), ACM Digital Library, IEEE Xplore, Education Resource Information Center (ERIC) (EBSCOhost), PsycINFO (Ovid), CINAHL (EBSCOhost), Medline (Ovid), Embase (Ovid), and Web of Science (Clarivate Analytics). The database searches will be updated before final analysis. The search strategy has been developed in cooperation with a research librarian at Western Norway University of Applied Science. The search string has been peer reviewed by another research librarian, according to the Peer Review of Electronic Search Strategies (PRESS) [17]. A comprehensive search strategy combining text and mesh words relating to health care students and mobile apps was developed. The Boolean operator OR will combine words of similar meaning and the Boolean operator AND will combine searches with words of different meanings. The search strategy for PsycINFO is presented in Multimedia Appendix 1. We will tailor the search strategy to the other databases and present it in our scoping review.

We will browse OpenGrey for grey literature. We will perform a citation search in Google Scholar for included studies and screen reference lists for possible relevant studies. There will be no language restrictions. Studies from January 2008 to the date the searches are run will be sought. The year restriction has been chosen as mobile apps did not appear until 2008 [18].

Stage 3: Data Selection (Selecting Studies)

The Rayyan online management software [19] will be used for the selection of eligible studies. Based on the inclusion criteria outlined in Textbox 1, two authors will independently screen the titles and abstracts of studies retrieved from the searches to identify eligible studies We will include research articles of both quantitative and qualitative designs within the area of health care professional education. Commentaries, discussion papers, book editorials, and conference abstracts will be excluded. Moreover, studies relating to learner management systems, e-learning platforms, open online courses, or distance education will be excluded. Studies will be screened in full text, if one reviewer decides to include it. The full text of these potentially eligible studies will be retrieved, imported to the EndNote X9 reference management system [20], and independently assessed for eligibility by two review authors. Any eligibility disagreements will be resolved through discussion or with a third reviewer. A flow chart of the study selection process will be presented.

Textbox 1. Study eligibility.

Inclusion criteria

Population: Studies reporting on health care and allied health care students at the undergraduate and postgraduate levels.

Concepts: Studies of usability testing or usability evaluation methods of mobile apps, where the purpose is related to development of the apps. The usability attributes include effectiveness, efficiency, satisfaction, learnability, memorability, errors, simplicity, comprehensibility, and learning performance of the learning app.

Context: Typical educational settings (eg, classroom teaching, clinical placement, and simulation training).

Stage 4: Charting the Data

A standardized prepiloted data extraction form will be used to extract characteristics and data from the included studies. One review author will extract the data from the included studies, which will be checked by another review author. A combination of Microsoft Excel software [21] and NVivo 12 [22] will be used to facilitate this process. Discrepancies will be identified and resolved through discussion or with a third author when necessary.

The process of extracting information from the included studies in a scoping review is an iterative approach [12,13]. This means that we will extract predefined themes, although other relevant information may be included later in the process. Extracted information related to the purpose of the scoping review will include the following:

(1) Study: author(s) name(s), year of publication, title, country, publication journal, study setting, study design, research question, and research methods

(2) Population: number of participants, description of participants, and education level

(3) Concepts: usability methods, usability attributes, modes of delivery, usability phase, materials, procedures, type(s) of location(s), number of usability testing procedures, and modifications

(4) Context: educational setting

Stage 5: Summarizing and Reporting the Results

The fifth stage of the scoping review involves summarizing and reporting the results of the included studies [11-13]. The characteristics of each study will be mapped, and a descriptive narrative account will be presented. We will perform a content analysis [23] to map the different usability methods and usability attributes used in the included studies. Tables and graphical illustrations will be used to bring together and present the usability methods and attributes.

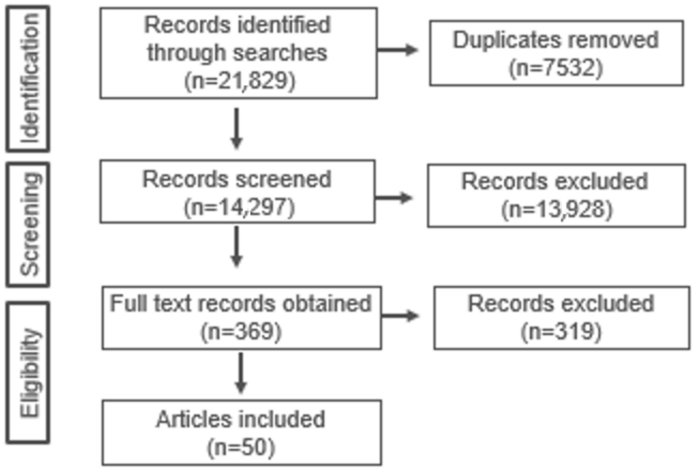
Ethics

This protocol for a scoping review does not require ethical approval or consent to participate. The data consist of data from published articles and do not include individual data.

Results

The electronic searches for eight of the databases were completed on March 5, 2019. The literature search identified 14,297 unique references (Figure 1). Owing to the sensitivity of the search, many of these references were irrelevant and excluded. Following title and abstract screening, full texts of 369 records were obtained. Our next step is to assess these references for eligibility.

Figure 1. Flow chart of the search results and screening process.



Discussion

Usability Studies of Mobile Apps for Health Care Education

The increasing acceptability and use of mobile apps in the health care education context can lead to improved learning outcomes. However, in order to make learning tools relevant to students, mobile apps must meet the expectations of users [4]. To our knowledge, no overview exists on usability studies of mobile apps for health care education. The results of this scoping review will provide valuable information to developers of mobile apps for health care education, as it will point to relevant usability methods and attributes. Furthermore, the review will identify areas where further research is needed.

A strength of this study is the broad search strategy. We searched ten different databases, and the search strategy was designed in collaboration with a research librarian and was peer reviewed by another research librarian. The search has a time restriction from 2008, but no language restriction. The time restriction was set from 2008, as mobile apps appeared in 2008. A broad search strategy may be associated with lower precision, making it challenging to retrieve relevant articles. We did however experience some challenges with the initial database searches. The authors and research librarians had little experience with databases in academic areas outside health care (eg, Engineering Village and Scopus). “Usability” was not used as a term in the search strategy, as studies on usability do not necessarily refer to or use the term usability. Designing an effective search strategy that balances sensitivity and precision was demanding. Consequently, the search was challenging to narrow, and the search yielded 14,297 unique hits. To ensure that members of the review team had a similar understanding of the inclusion and exclusion criteria, efforts were made to calibrate our screening. Reporting methodological rigor and transparency in a scoping review is of importance to the trustworthiness of the research [24]. Publishing a protocol of the scoping review will support the transparency of the methodology and will assist in the conduction of the scoping review. Following the reporting guidelines for scoping reviews (PRISMA-ScR) [14] will help ensure the methodological quality of the scoping review.

Conclusion

This scoping review will advance the field of mobile app development for health care education by presenting advice on the relevant usability methods and attributes to study. It will give an overview of the field and provide researchers and developers with relevant and important information on the usability research area, including highlighting possible research gaps.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Search string for PsycINFO.
[DOCX File , 17 KB-Multimedia Appendix 1]

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Abbreviations

ISO: International Organization of Standardization

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TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 06.10.2016. Meldingen gjelder prosjektet:

50425	*Bruk av en mobilapplikasjon for å fremme kunnskapsbasert praksis blant helse- og sosialfagstudenter*
Behandlingsansvarlig	*Høgskolen i Bergen, ved institusjonens øverste leder*
Daglig ansvarlig	*Nina Rydland Olsen*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, ombudets kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/meldeplikt/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://pvo.nsd.no/prosjekt.

Personvernombudet vil ved prosjektets avslutning, 31.12.2020, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Kjersti Haugstvedt

Siri Tenden Myklebust

Kontaktperson: Siri Tenden Myklebust tlf: 55 58 22 68
Vedlegg: Prosjektvurdering

Dokumentet er elektronisk produsert og godkjent ved NSDs rutiner for elektronisk godkjenning.

Personvernombudet for forskning

Prosjektvurdering - Kommentar

Prosjektnr: 50425

PROSJEKTDESIGN
Hensikten med studien er å utforske bruken av en mobilapplikasjon i kunnskapsbasert praksis blant studenter fra helse- og sosialfag. Studien består av to delprosjekt: I delprosjekt1 vil man hente informasjon fra en mobilapplikasjon som studentene benytter. I delprosjekt 2 vil det gjennomføres fokusgruppe- og/eller individuelle intervjuer med brukerne av mobilapplikasjonen.

UTVALG OG REKRUTTERING
Utvalget består av studenter ved Høgskolen i Bergen, anslagsvis 400 stykker forventes rekruttert til studien. Studentene rekrutteres via oppslag på læringsplattformen It`s Learning.

INFORMASJON OG SAMTYKKE
Utvalget informeres skriftlig om prosjektet og samtykker til deltakelse. Informasjonsskrivene er godt utformet, men vi ber imidlertid om at følgende tilføyes før utvalget kontaktes:
- I informasjonsskrivet til deltakere i delprosjekt 1 må det presiseres at også brukerkonto med tilhørende persondata slettes ved prosjektslutt.

DATASIKKERHET
Personvernombudet legger til grunn at dere behandler alle data i tråd med Høgskolen i Bergen sine retningslinjer for datasikkerhet.

DATABEHANDLERAVTALE
ProISP er databehandler for prosjektet. Høgskolen i Bergen skal inngå skriftlig avtale med ProISP om hvordan personopplysninger skal behandles, jf. personopplysningsloven § 15. For råd om hva databehandleravtalen bør inneholde, se Datatilsynets veileder: http://www.datatilsynet.no/Sikkerhet-internkontroll/Databehandleravtale/.

PROSJEKTSLUTT OG ANONYMISERING
Forventet prosjektslutt er 31.12.2020. Ifølge prosjektmeldingen skal innsamlede opplysninger da anonymiseres. Anonymisering innebærer å bearbeide datamaterialet slik at ingen enkeltpersoner kan gjenkjennes. Det gjøres ved å:
- slette direkte personopplysninger (som navn/koblingsnøkkel/epostadresse)
- slette/omskrive indirekte personopplysninger (identifiserende sammenstilling av bakgrunnsopplysninger som f.eks. bosted, utdanning, alder og kjønn)
- slette digitale lydopptak

Vi gjør oppmerksom på at også databehandler (ProISP) må slette personopplysninger tilknyttet prosjektet i sine systemer. Dette inkluderer eventuelle logger og koblinger mellom IP-/epostadresser og besvarelser.

Sikt

Meldeskjema / Bruk av en mobilapplikasjon for å fremme kunnskapsbasert praksis bla... / Vurdering

Vurdering av behandling av personopplysninger

Referansenummer	Vurderingstype	Dato
929814	Standard	06.11.2019

Tittel
Bruk av en mobilapplikasjon for å fremme kunnskapsbasert praksis blant helse- og sosialfagstudenter

Behandlingsansvarlig institusjon
Høgskulen på Vestlandet / Fakultet for helse- og sosialvitskap / Institutt for helse og funksjon

Prosjektansvarlig
Nina Rydland Olsen

Prosjektperiode
01.01.2020 - 31.12.2025

Kategorier personopplysninger
Alminnelige

Lovlig grunnlag
Samtykke (Personvernforordningen art. 6 nr. 1 bokstav a)

Behandlingen av personopplysningene er lovlig så fremt den gjennomføres som oppgitt i meldeskjemaet. Det lovlige grunnlaget gjelder til 31.12.2025.

Meldeskjema

Kommentar
BAKGRUNN
Behandlingen av personopplysninger ble opprinnelig meldt inn til NSD den 06.10.2016 (NSD sin ref: 50425) og vurdert under personopplysningsloven som var gjeldende på det tidspunktet. Prosjektet er meldt på nytt grunnet utvidelse av prosjektperioden og ny datainnsamling.

VURDERING
Det er vår vurdering at behandlingen/hele prosjektet vil være i samsvar med den gjeldende personvernlovgivningen, så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet den 06.11.2019 med vedlegg, samt i meldingsdialogen mellom innmelder og NSD. Behandlingen kan fortsette.

MELD VESENTLIGE ENDRINGER
Dersom det skjer vesentlige endringer i behandlingen av personopplysninger, kan det være nødvendig å melde dette til NSD ved å oppdatere meldeskjemaet. Før du melder inn en endring, oppfordrer vi deg til å lese om hvilke type endringer det er nødvendig å melde:
https://nsd.no/personvernombud/meld_prosjekt/meld_endringer.html
Du må vente på svar fra NSD før endringen gjennomføres.

TYPE OPPLYSNINGER OG VARIGHET
Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til 31.12.2025. Datamaterialet som allerede er samlet inn vil anonymiseres innen 31.12.2020.

LOVLIG GRUNNLAG
Prosjektet har innhentet samtykke fra de registrerte til behandlingen av personopplysninger. Det vil innhentes samtykke fra nye deltakere (Utvalg 1 og 2 i meldeskjemaet).

Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 og 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse som kan dokumenteres, og som den registrerte kan trekke tilbake.

Lovlig grunnlag for behandlingen er dermed den registrertes samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a.

PERSONVERNPRINSIPPER

Forespørsel om deltakelse i forskningsprosjektet

BRUK AV EN MOBILAPPLIKASJON FOR Å FREMME KUNNSKAPSBASERT PRAKSIS BLANT HELSE- OG SOSIALFAGSTUDENTER

Bakgrunn og formål
Som et ledd i satsningen på kunnskapsbasert praksis har myndighetene gjennom HelseOmsorg21 fremmet forslag om at opplæring i kunnskapshåndtering og kunnskapsbasert praksis må bli obligatorisk i alle helsefagutdanninger. Ved Høgskolen på Vestlandet (HVL) har vi utviklet en mobilapplikasjonen, et digitalt læringsverktøy og en teknisk løsning, designet for å støtte studenter i å lære og å jobbe kunnskapsbasert.

Hensikten med dette prosjektet er å utforske erfaringer knyttet til bruk av denne mobilapplikasjon blant studenter fra helse- og sosialfag.

Vi ønsker å intervjue studenter fra ulike utdanninger ved Avdeling for helse og sosialfag, HVL, som har brukt mobilapplikasjonen i praksis. Vi ønsker å gjennomføre 2-3 fokusgrupper per semester i perioden 2016-2018, og vil forsøke å rekruttere ca. 70 studenter.

Hva innebærer deltakelse i studien?
Fokusgruppeintervju vil finne sted i lokaler ved HVL, og gruppene vil bestå av 3-8 deltakere. Intervjuet vil ta utgangspunkt i en utarbeidet intervjuguide og ledes av forskere knyttet til prosjektgruppen. En medhjelper vil også være tilstede. Fokusgruppeintervjuet vil ha en varighet på ca. 1,5 time og vil bli tatt opp på bånd. Fokus for intervjuene vil være studentenes erfaringer knyttet til bruk av en mobilapplikasjon som et læringsverktøy i kunnskapsbasert praksis.

Hva skjer med informasjonen om deg?
Alle personopplysninger vil bli behandlet konfidensielt. Intervjuene vil bli fortløpende transkribert og analysert. Innsamlede data vil bli lagret på et lukket lagringsområde på forskningsserveren til HVL. Opplysningene anonymiseres når prosjektet er ferdigstilt, innen 31.12.2020. Resultatene vil gjøres kjent som rapporter og bli publisert i nasjonale og internasjonale tidsskrift. Ved publisering vil det ikke fremgå opplysninger som kan tilbakeføres til deg.

Nina Rydland Olsen er ansvarlig for prosjektet og datamaterialet, og vil kunne inkludere masterstudenter eller andre ansatte ved institusjonen i prosjektet i løpet av prosjektperioden. Prosjektet skal etter planen avsluttes i 31.12.2020. Prosjektmedarbeiderne har taushetsplikt og alle opplysninger som fremkommer fra deg vil bli behandlet konfidensielt. Ved prosjektslutt vil materialet være anonymisert og lydopptakene slettet. Prosjektet er meldt til Norsk senter for forskningsdata (NSD), som er høgskolens personvernombud for forskning.

Frivillig deltakelse
Det er frivillig å delta i studien, og du kan når som helst trekke deg uten å oppgi noen grunn. Dersom du velger å trekke deg, vil alle opplysninger om deg bli slettet. Dette vil ikke få noen konsekvenser for ditt utdanningsforløp eller ditt forhold til ansatte ved HVL. Dersom du har spørsmål til studien, ta kontakt med prosjektleder Nina Rydland Olsen på mail nro@hvl.no eller tlf. 41313204. Om du ønsker å delta er det fint om du signerer vedlagt samtykke skjema.

Med vennlig hilsen

Nina Rydland Olsen
Fysioterapeut, PhD
Institutt for ergoterapi, fysioterapi og radiografi
Avdeling for helse og sosialfag
Høgskolen på Vestlandet

Samtykke til deltakelse i studien

Jeg har mottatt informasjon om studien, og er villig til å delta

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(Signert av prosjektdeltaker, dato)

BRUK AV EN MOBILAPPLIKASJON FOR Å FREMME KUNNSKAPSBASERT PRAKSIS BLANT HELSE- OG SOSIALFAGSTUDENTER – BAKGRUNNSINFORMASJON

Ditt navn: ______________________ **Intervjudato:** ______________________

Hvilken utdanning er du student ved (program, år/kull): ______________________

Alder: ________ **år** **Kjønn:** ☐ mann ☐ kvinne

OM PRAKSISPLASSEN:

Har du hatt tilgang til Internett på praksisplassen? ☐ Ja ☐ Nei

Har du hatt tilgang til Internett hjemme i løpet av praksisperioden? ☐ Ja ☐ Nei

Har du hatt praksis i spesialisthelsetjenesten? ☐ Ja ☐ Nei

Har du hatt praksis i kommunehelsetjenesten? ☐ Ja ☐ Nei

Har du hatt praksis i utlandet? ☐ Ja ☐ Nei

Annet? ____

OM UTDANNING OG ERFARING:

Har du fullført en tidligere bachelorutdanning? ☐ Ja ☐ Nei

Hvilken? ______________________

Har du fullført en tidligere masterutdanning? ☐ Ja ☐ Nei

Hvilken? ______________________

Hvis du har klinisk erfaring, hvor mange års erfaring har du? ________ **år**

Andre kommentarer?

____

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