Research protocol: Technology-supported guidance to increase flexibility, quality and efficiency in the clinical practicum of nursing education

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ABSTRACT

This paper presents the protocol for a randomized controlled trial aimed at studying the effects of a technology-supported guidance model delivered by smartphone and intended to strengthen the follow-up of nursing students during their clinical practicum. The research outcomes will reflect students' critical thinking, learning outcomes, and satisfaction. The results will be compared before and after the intervention and between control and intervention groups. In the control group, the clinical practicum period will be performed as usual. In the intervention group, students will monitor their day by filling in daily electronic reports. Based on students' reports and the day's experience, the nurse preceptor will give a feedback to the students. A process evaluation will measure fidelity and potential for scale-up.

1. Background

1.1. Significance

In Norway, fifty percent of the baccalaureate nursing program consists of a clinical practicum. The clinical practicum is mainly conducted according to a guidance model that involves three parties: a nurse educator (NE) employed by an educational institution (university or university college), a nursing student (NS), and a nurse preceptor (NP). The NP is employed by the healthcare institution where the NS undertakes the clinical practicum period. The NP is responsible for daily face-to-face guidance, which includes follow-up, support, and assessment of the NS's professional development during their clinical practicum. The NE is a pedagogical mediator who assures, through distance cooperation, that the clinical practicum is performed in such a manner that it provides the NS with an optimal learning experience according to the curriculum. European countries such as Norway, Sweden, United Kingdom, Spain, Italy, the Netherlands, and Finland have adopted this guidance model (Saarikoski et al., 2013; Strandell-Laine, Stolt, Leino-

Kilpi, & Saarikoski, 2015). The challenge for the current guidance model is the limited possibility for contact between the involved parties (NS-NE and NP-NE) with communication being limited to emails and telephone calls when needed (Saarikoski et al., 2013). There are only a few face-to-face meetings (on startup and at midterm and final evaluations) where all three parties are involved (NS-NE-NP). NSs report feeling isolated from their NE and peers, and regret the limited opportunities they have to cooperate with their NE (Killam & Heerschap, 2013). The varying pedagogical competency of the NPs is also a challenge, because their abilities will directly affect the learning outcomes of the NSs they supervise. A Norwegian study points to this problem and refers to dissatisfaction among NSs with their clinical practicum (Helmers, 2006). This challenge seems equally relevant today: a report from The Norwegian Nurses Organization (NNO) from 2018 shows that the framework of conditions for the clinical practicum guidance of baccalaureate NSs in municipal healthcare is a cause for concern and relates to the quality of their clinical practicum. This report shows that NPs have little formal pedagogical competence in supervision, little time for guidance, and few incentives to become involved in guidance. Everyone involved in nursing education (educational institutions, healthcare institution, NNO and NSs) agree that something needs to be done to improve the quality of the nursing clinical practicum (Norsk Sykepleieforbund, 2018).

In Norway, the need for nurses is increasing (KD, 2019); strategies are needed to increase the admission of new NSs and to stimulate undergraduate NSs to complete their studies within the regular time. The current clinical guidance model and the lack of clinical practicum placements near educational institutions are limitations to finding a feasible solution for this increasing problem. The possibility of finding clinical practicum placements far from the educational institutions, both nationally and internationally, by using a method where the quality of the practicum could be ensured would be a great help.

Another central challenge in the clinical practicum relates to the terms and expressions used by the nursing profession. It is important to ensure consistent use of words and concepts so that information is perceived equally by different readers (Laukvik, Mølstad, & Fossum, 2017). There is a need for a professional language that can promote common understanding and continuity in nursing. The International Classification of Nursing Practice (ICNP®) contributes to a common language for the nursing profession. ICNP® is a classification system designed to be an integral part of healthcare practice information and nursing practice. The Norwegian Directorate of e-health recommends the ICNP® as a national terminology for nursing documentation in patient records (Direktoratet for e-helse, 2018). Internationally, the World Health Organization (WHO) has recommended that ICNP® should be used to classify patient data and clinical activities in the field of nursing and should be used in decision making and in the development of policies to improve health services. In 2008, the NNO recommended the ICNP® terminology for use in nursing practice and documentation. At present, several institutions in Norway plan to implement ICNP® into their educational programs to enable NSs and future nurses to use the ICNP®. The University of Agder (UiA) hosts the Norwegian Research and Development Center for ICNP® (N-ICNP) as certified by the International Council of Nurses (ICN).

In order to meet the challenges mentioned in relation to the nursing clinical practicum, a new guidance model, supported by technology, has been proposed by the Lovisenberg Diaconal University College (LDUC). The LDUC's guidance model is designed to assure the quality of the clinical practicum independent of the pedagogical skills of the local NP and the geographic location of the clinical practicum placement, as this will increase the educational capacity. Another objective of the proposed guidance model is to increase standardization and improve documentation in nursing.

Information technology plays a key role in modern society, and great advances have been made in recent years, especially in the field of digital communication. The use of wireless devices in communication, such as smartphones, tablets, and computers, has become an integral part of society. Most of the people who are starting their college education today already use mobile devices to access social networking and applications related to their daily communication (Hansen & Erdley, 2009). Communication is the main tool used in education, consequently this technological development opens up many opportunities in this field, facilitating active learning and providing the structure necessary for exploring the effectiveness of a guidance model for the clinical practicum that would be supported by mobile technology, such as the smartphone or tablet, and as applicable to higher education (Doyle, Garrett, & Currie, 2014; Raman, 2015; Strandell-Laine et al., 2015).

To the best of our knowledge, only one randomized controlled trial (RCT) has been conducted to explore the use of a smartphone/tablet application aimed at improving communication between NSs and NEs during the clinical practicum (Strandell-Laine et al., 2017). However, in this study conducted in Finland, the NPs and the ICNP® terminology were not included. Although the Norwegian government emphasizes the need and encourages research that applies technology in education (KD, 2017), no studies that aim to improve the conditions of the clinical practicum for baccalaureate NSs through the use of mobile technology have been reported from Norway. Furthermore, no studies supported by mobile technology have been conducted that propose to a) increase NPs' pedagogical competence, b) ensure the quality of the clinical practicum and the attainment of learning outcomes by NSs, c) improve communication between the involved parties (NE, NS and NP), d) promote remote follow-up by NEs through increased flexibility and efficiency, and e) promote collaboration to result in increased educational capacity. Thus, there is a need for such a study in nursing education.

1.2. Intervention

The scope of the proposed research project is to develop, test and implement a guidance model supported by mobile technology with the aim of increasing the quality, flexibility, and efficiency of the clinical practicum in baccalaureate nursing education. This new guidance model can be used independently of the geographical location of the clinical placement. To achieve this objective, a smartphone/tablet application will be developed, tested, and evaluated. The application will enable NSs to complete daily electronic reports (e-reports) and receive tailored situational feedback from a NP and a NE. Daily e-reports both before and after a shift are metacognitive strategies that stimulate self-regulated learning and increase critical thinking skills (Arsal, 2010; Ekahitanond, 2013;

Ku & Ho, 2010; Samsonovich, Kitsantas, Dabbagh, & De Jong, 2008). Continuous feedback is fundamental to the NS's professional development, providing direction and helping to develop confidence, increase motivation, and establish self-esteem. It can also enable NSs to evaluate their learning outcomes in the clinical placement in a realistic way (Ekahitanond, 2013; Hattie & Timperley, 2007). This guidance model will permit the NPs and NEs to supervise, follow-up, and support the NSs' learning progress continuously and to intervene rapidly when necessary. In addition, the scheduled meetings will be held virtually, and assessment will be done digitally in the application.

The proposed new guidance model also aims to ensure the NSs' attainment of learning outcomes in their clinical placements, to improve communication and collaboration between NSs, NEs and NPs, to improve the quality of nursing documentation by using the ICNP®, and to ensure the development and knowledge of NSs and their satisfaction with their clinical practicums. The new guidance model is also designed to improve NPs' pedagogical competence and to include the follow-up of each NP and NS to ensure that the education has been given and executed according to the LDUC's prescribed pedagogical methods and the learning objectives of the nursing curriculum.

The present study forms an important part of the redesign of all the learning objectives related to the clinical practicum of the baccalaureate nursing program at LDUC, and it is connected to the implementation of a new curriculum for the nursing program in Autumn 2020. The new mobile technology-supported guidance model for the clinical practicum will be tested in 2021 during the baccalaureate nursing program at LDUC.

1.3. Underpinning theory of intervention

The intervention is theoretically based on the concept of metacognition which refers to cognitive processes, the ability to "think about one's own thinking" and are necessary in order to develop critical thinking skills (Ku & Ho, 2010). Metacognition can be understood as a metacognitive cycle and is based on three main phases: planning and setting goals; applying strategies and monitoring progress; and evaluating and adapting approaches. These phases may be further influenced by factors, such as task constraints, beliefs about learning, knowing one's own strengths and weaknesses and individual motivation. Subsequently, critical thinking develops through the use of these metacognitive processes (Arsal, 2010; Butler, 1997; Magno, 2010; Pintrich, 2000; Winne & Hadwin, 1998).

Concerning the outlined intervention, through the use of e-reports in the mobile guidance application, at the start of each day in clinical practice, NSs can plan and set their goals for the day, and what they want to learn, explore or experience. When the planning and setting of goals are concluded NSs apply the necessary strategies to be able to meet the plans/goals that have been set; and monitor their own progress. At the end of the day, through the e-reports in the mobile guidance application, the NSs evaluate and adapt their approaches based on what they have experienced or learnt throughout the day. NPs offer feedback through the e-reports at the end of the day, which allows further reflection over what goals should be set, and which approaches should be applied to meet the identified goals. In addition, NPs can enter this metacognitive cycle at any stage, through one-to-one feedback or guidance and further contribute with feedback, suggestions or guidance to any of the steps in the metacognitive cycle.

2. Research plan

2.1. Research questions

How does the LDUC's new guidance model supported by mobile technology affect:
Primary research question:

1 The NSs' and NPs' critical thinking skills?

To answer the primary research question the *Health Sciences Reasoning Test* (HSRT) (Facione & Facione, 1994) will be applied (primary outcome).
Secondary research questions:

1 The NSs' and NPs' competence?
2 The NSs' and NPs' self-efficacy?
3 The NSs' and NPs' mobile technology acceptance?
4 The NSs' and NPs' satisfaction with the clinical practicum?
5 The use of ICNP® terminology for nursing documentation by NSs and NPs?
6 The communication and cooperation between NSs, NPs and NEs?
7 The flexibility and efficiency of the clinical practicum by facilitating the NEs' remote follow-up and support provided to the NSs and NPs?

The generic Nurse Competence Scale (NCS) will be applied to answer the secondary research question 1. The Self-Efficacy in Clinical Performance instrument (SECP) will be applied to answer the secondary research question 2. The Technology Acceptance Model 3 (TAM3) instrument will be applied to answer the secondary research question 3. The Clinical Learning Environment, Supervision and Nurse Teacher (CLES + T) instrument will be applied to answer the secondary research question 4. The secondary

research questions 5, 6, 7 will be answered by performing analysis of the mandatory written assignments in the clinical practicum period. In addition, focus group interviews will be applied to gain an understanding of the intervention implementation and outcomes.

2.2. Hypotheses

With regard to previously published studies relating to use of mobile technology and metacognition strategies in education, it is hypothesized that:

(1) The NSs' and NPs' critical thinking skills, competence, self-efficacy, technology acceptance, and satisfaction with the clinical practicum will significantly increase in the intervention group compared with the control group.
(2) The LDUC's new guidance model supported by mobile technology will increase the use of ICNP® terminology in nursing documentation.
(3) The communication and cooperation between NSs, NPs and NEs will improve in the intervention group compared with the control group.
(4) The LDUC's new guidance model supported by mobile technology will increase flexibility and efficiency of the clinical practicum in nursing education, regardless of the clinical practicum's geographical location.

2.3. Design

An experimental design will be applied and conducted in three main phases (test, pilot and RCT), performed in cooperation with the end-users (NSs, NEs and NPs) of the new guidance model.

In the control group, the clinical practicum period will be performed as usual, i.e., the NE will be present at the healthcare institution three times during the eight-week duration of the NS's clinical practicum. Moreover, the learning activities will be delivered to the NE through the Canvas LDUC's learning management system, and the scheduled NS-NE-NP meetings will be performed face-to-face. In the intervention group, the mobile technology-supported guidance model will be applied.

As mentioned previously, metacognitive and self-regulating strategies form the theoretical basis of the study intervention. These are summarized as the individual's being active in his own learning process behaviorally, metacognitively, and motivationally, and they include three general types of strategy: planning, monitoring, and regulating (Arsal, 2010; Butler, 1997; Magno, 2010; Pintrich, 2000; Winne & Hadwin, 1998). These strategies are included in the LDUC guidance model and are integrated into three main components: 1) an application that includes e-reporting, and feedback that includes ICNP®; 2) virtual meetings; and 3) digital assessment. These three components are described more precisely in the following sections.

1) E-reports, feedback, including ICNP®:
   NSs will be required to closely monitor their days at the clinical practicum by filling out daily e-reports on an application. Their answers will be available for immediate analysis by the NP, who will send a feedback message to the NS based on the e-report and the day's experience. The system will allow the NP to warn the NE when a specific situation requires the NE's involvement. After receiving an alarm from the application, the NE will evaluate the situation and send tailored, written feedback to the NS and the NP, based on information from the analyzed e-reports. In special cases, face-to-face contact with the NS and NP can be initiated to fully understand the situation. In the same way, the NS can notify the NE directly if they need support.
   The format of the e-reports will be a multiple-choice questionnaire in the application. The questions will be based on the NSs' common daily plan for the clinical practicum period and will be related to the main areas of nursing competence, including clinical competence (nursing process, clinical decision-making, procedures, knowledge, documentation, and reports), management competence (planning, managing, distributing work tasks, nursing leadership, and collaboration), social competence (communication with patients, their families, and the work team), and ethical competence (awareness of ethical and ideological principles, accuracy, and reliability). The e-reports will also include a comment field providing the users with the opportunity to write a short personal message to the NP and NE. These e-reports will be completed by the NS at the beginning and end of each practicum shift. Reminders to fill in the e-reports will be sent automatically. Previous comparable studies using electronic diaries report positive experiences by the users (Kristjánsdóttir et al., 2011; Nes et al., 2012).
   By using the new guidance model for the clinical practicum, potential challenges in the NS's clinical practicum can be addressed at an early stage and corrective actions initiated to avoid a problem becoming serious (Kristjánsdóttir et al., 2013; Nes et al., 2012). By maintaining daily e-reports, the NS will have the opportunity to update and set new goals for their learning and then attempt to monitor, regulate, and control their results, cognition, motivation, and behavior as an active process (Arsal, 2010).
   The technological solution will guarantee immediate, reliable, safe, and unidentified transmission and storage of data (e-report, tailored feedback, and messages) on a secure server (Kristjánsdóttir et al., 2011; Kristjánsdóttir et al., 2013; Nes et al., 2012).
2) Virtual meetings:
   The group meetings held during the clinical practicum in nursing education at LDUC form part of the teaching strategy and aim to stimulate the NSs' reflection and to support the NSs in achieving the desired learning outcomes.
   Currently, the group meetings are held on campus three times during the clinical practicum period. Consequently, several NSs spend a great deal of time traveling between their practicum placements and the campus. The current guidance model does not cover the NSs' need for an accessible meeting place.
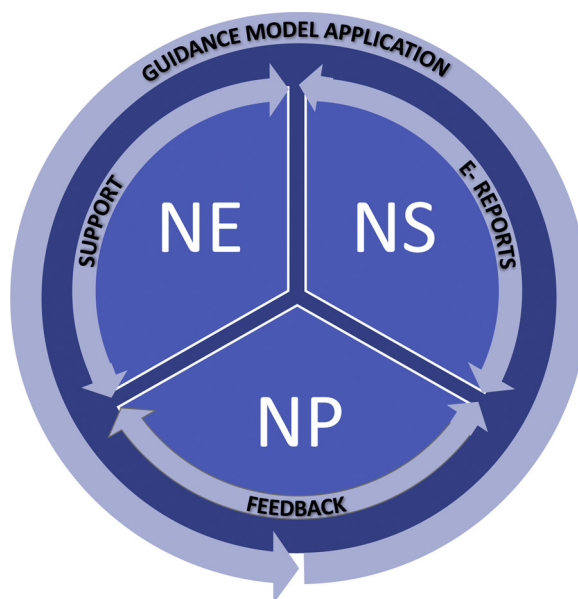
Fig. 1. Mechanism of LDUC's guidance model application.

By implementing virtual group meetings, opportunities will arise for an increased number of meetings, ensuring interaction, dialogue, and reflection, regardless of location. Thus, virtual meetings should enable improved collaboration between NSs, NPs, and NEs. Participants can interact with each other synchronously through their devices, through speech, by writing questions and comments, and by sharing files (Slåtto, Creelman, Schneider, Röthler, & Árnason, 2016).

3) Digital assessment:

LDUC's new guidance model for the clinical practicum includes digital assessment intended to effectively assess, measure, and help students to improve their learning outcomes by: a) examining what the NSs have learned, b) receiving feedback from the NE and NP, and c) enabling self-assessment. This form of assessment contributes to the development of critical thinking skills (Jeno, 2018).

LDUC has already introduced digital assessment of the clinical practicum through a form that is filled out in personal meetings. For this project, assessment meetings will be arranged virtually. The NS and NP will complete the assessment form in advance, and this will be calibrated and adjusted in meetings if necessary. This may strengthen the NSs' self-evaluation and the NPs' preparation for the assessment. The digital assessment will be accessed through a common electronic identity for educational institutions in Norway (FEIDE), ensuring security of personal information (see Fig.1).

2.3.1. Technology

The functionality required for the e-reports and feedback will be programmed into a smartphone/tablet application via the standard application interface. A web meeting tool will be used for the virtual meetings. In the project, an individual webinar system will enable the NSs, NE and the NPs to interact through their respective units.

2.4. Participants

NSs (N = 100/2) with their clinical supervisors (N = 100/2) will be recruited through an announcement on Canvas with information on the study and an invitation to participate. If respondents fulfil the inclusion criteria, the researcher will explain the purpose of the study further and how the study will be conducted. After the participants have signed an informed consent form, they will be randomly allocated (by lottery) to either the intervention or the control group (see Fig. 2) .

Inclusion criteria: a) be a NS in the baccalaureate nursing program at LDUC, or a NP for LDUC's NSs during their clinical practicum period; b) have the capability to fill in Norwegian questionnaires electronically; c) be able and willing to give signed informed consent; d) be willing to attend the preparatory course on how to complete the e-questionnaires and e-reports; e) be willing to use smartphones, tablets and/or computers.

2.5. Outcome measures

The outcome variables will be collected from NSs and NPs from both the intervention group and the control group by the use of electronic self-report questionnaires. Results will be considered statistically significant at $p < 0.05$ for each of the questionnaires described below.
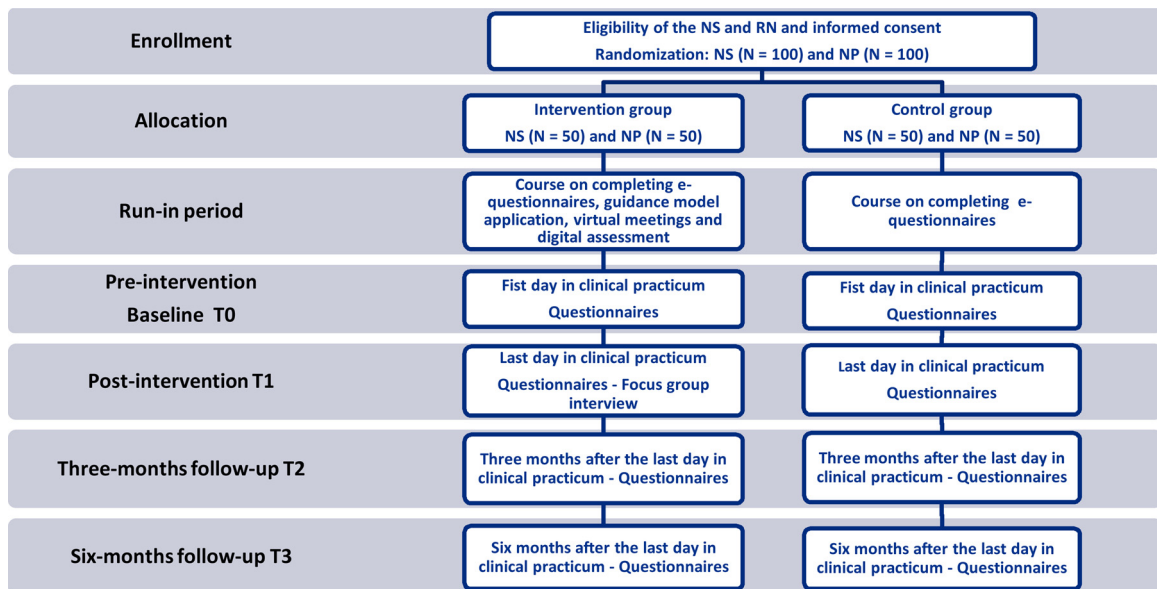
Fig. 2. Flow diagram of the RCT with data collection.

2.5.1. Primary outcome

The *Health Sciences Reasoning Test (HSTR)* (Facione & Facione, 2006), is a 38-question, multiple-choice test designed to assess the critical thinking skills in health sciences students. Critical thinking skills are required to succeed in settings where problem solving and decision making are important. Internal reliability is reported as acceptable with a Cronbach's alpha of .76 for the overall instrument (Campbell, 2017).

2.5.2. Secondary outcomes

The generic *Nurse Competence Scale (NCS)* (Meretoja, Isoaho, & Leino-Kilpi, 2004), tested and validated in Norway, measures nurse competence and contains 73 items in seven competence sub-scales: helping role (7 items), teaching–coaching (16 items), diagnostic functions (7 items), managing situations (8 items), therapeutic interventions (10 items), ensuring quality (6 items), and work role (19 items). Internal reliability is reported as acceptable with a Cronbach's alpha for each item that ranged from .79 to .91 (Meretoja et al., 2004).

The *Self-Efficacy in Clinical Performance instrument (SECP)* (Cheraghi, Hassani, Yaghmaei, & Alavi-Majed, 2009), measures self-efficacy in clinical performance and contains 37 items in four sub-scales: assessment (12 items), diagnosis and planning (9 items), implementation (10 items), and evaluation (6 items). Internal reliability is reported as acceptable with a Cronbach's alpha for each item that ranged from .90 to .92 (Cheraghi et al., 2009).

The *Clinical Learning Environment, Supervision and Nurse Teacher (CLES + T$_2$)* evaluation scale measures satisfaction with the clinical learning environment (Saarikoski & Leino-Kilpi, 2002; Strandell-Laine et al., 2018). Internal reliability is reported as acceptable with a Cronbach's alpha for each item that ranged from .81 to .98 (Johansson et al., 2010).

The Technology Acceptance Model 3 (TAM3) (Venkatesh & Bala, 2008) provides a theoretical link between users' perceptions, attitudes, intentions, and acceptance or rejection of the use of technology (Davis, Bagozzi, & Warshaw, 1989). Overall, the TAM provides an informative representation of the mechanisms by which design choices influence user acceptance and should therefore be helpful for forecasting and evaluating user acceptance of information technology. Internal reliability is reported as acceptable with a Cronbach's alpha for each item that ranged from .77 to .87 (Al-Azawei, Parslow, & Lundqvist, 2017).

The use of ICNP® terminology, the communication and cooperation between NSs, NPs and NEs and the flexibility and efficiency of the clinical practicum will be evaluated by analyzing the NSs' mandatory written assignments in the clinical practicum period and qualitative analyses of performed focus group interviews.

2.5.3. Covariates

Additionally, information on potentially confounding factors and effect modifiers will be collected by means of self-reported socio-demographic data as for example age, gender, marital status, education, employment, and ethnic background.

2.6. Sample size calculations and analysis

The sample size (N) is dependent upon planned statistical analysis. In this study, several analyses will be performed, and it is not easy to estimate N without doing a proper power-analysis where all the necessary factors are taken into consideration. The pilot study will provide the necessary grounds for an estimation of sample size through power analysis, and that will be calculated on the basis of

the primary outcome, that is NSs' critical thinking skills at this point, we will give a rough estimate of the sample size needed based on a table provided by Hinkle, Jurs, and Wiersma (2003). Given an effect size of 0.5, a significance level of 0.05, a standard deviation of the outcome variable of 0.5, power at 0.80, and a two-tailed significance test, we estimate N to be 34 for each group. At this point, we will set the sample to 50 NSs + 50 RNs (intervention group) and 50 NSs + 50 RNs (control group). Missing data will be identified and treated as missing at random if levels remain under 5%. The odds ratios of having a missing value on each of these variables will be checked by multivariate logistic regression for being related to the important covariates as for example age, gender, study year, etc. However, if levels increase above 5% then analyses will be undertaken to explore patterns in the missing data and multiple imputation of missing variables will be considered.

2.7. Analysis plan

Differences between the two study groups will be analyzed with repeated measurement analysis of correlated data (multilevel analysis), using the statistical IBM SPSS Statistics for Windows software (version 23.0 or later, IBM Corp., Armonk, NY, USA).

2.8. Personnel

2.8.1. Principal investigators

Andrea Aparecida Gonçalves Nes, RN, MSc, PhD, Associate Professor at LDUC, Norway (project manager, researcher and main supervisor for the PhD student).

Edith Lillian Roth Gjevjon, RN, MSc, PhD, Associate Professor, Head of Institute at LDUC, Norway (member of the project group and co-supervisor for the PhD student).

Simen Alexander Steindal, RN, MSc, PhD, Associate professor at LDUC, Norway (member of the project group).

Marianne Trygg Solberg, RN, MSc, PhD, Associate professor at LDUC, Norway (member of the project group).

Jaroslav Zlamal, RN, MSc, Assistant Professor at LDUC, Norway (member of the project group and PhD student).

2.8.2. Co-investigators

Mariann Fossum, RN, MSc, PhD, Professor, Head of the Department of Health and Nursing Science, at University of Agder, Norway (co-supervisor for the PhD student).

Camilla Strandell-Laine, RN, MNSc, PhD, Head of Degree Program (Health and Welfare, Master's Degree) Novia University of Applied Sciences, Finland

2.9. Timeline

2.9.1. Project plan

The Fig. 3 illustrates all the activities and publications to be done in the project. The project will last for three and a haft year.
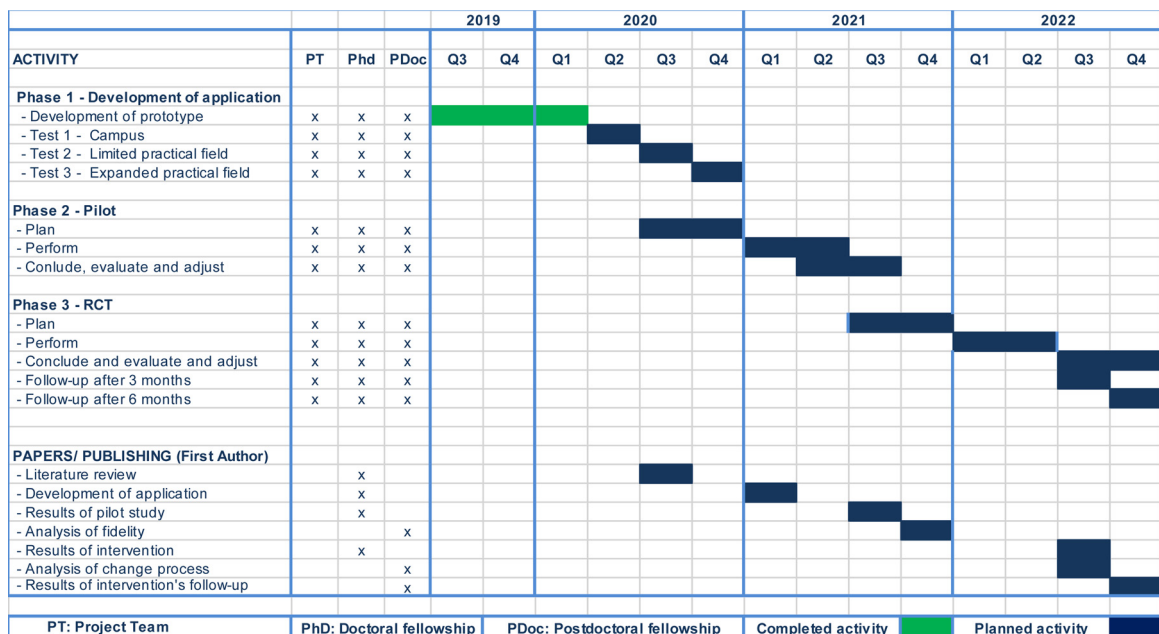

Fig. 3. Overview of activity plan.

2.10. Ethical aspects

Application for approval will be sent to the Norwegian Centre for Research Data (NSD). NSs and NPs will receive verbal and written information about the study at the start of the semester from a responsible recruiting researcher and educator. The participants will be required to give informed consent before participating in the study. They are guaranteed full confidentiality. They will also receive the information that participation in the study is voluntary and that they, at any time and without giving any reason, may withdraw their consent. This will not affect the NS's studies at LDUC nor the work situation of the NP. If a NS or NP withdraws from the study, they can require the deletion of the information collected unless that information has already been included in analyses or used in scientific publications.

The security associated with the server will assure the safety of the data provided during the intervention. No data will be saved on the users' devices. The data will be automatically encrypted, sent from the application to the server, and anonymously analyzed.

2.11. Potential impact of the proposed research

The resulting knowledge and experience will be shared with other university colleges and universities that utilize the clinical practicum as part of their educational process.

This study may contribute to ensuring and improving the quality of nursing education in the clinical practicum, impacting directly on the quality of nursing care given by NSs to patients. It may also contribute to the improvement of existing contacts, to the establishment of new contacts, and to cooperation between universities and national and international research centers involved in mobile technology-based nursing education.

The inadequacy of the nursing workforce is a growing problem in Norway. A positive outcome for this project may lead to an increased number of health care institutions being able to offer placements to NSs, which is currently the major bottleneck to increasing the number of educated nurses.

Declaration of Competing Interest

The authors report no conflicts of interest.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ijer.2020.101628.

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