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Effectiveness of mobile cooperation intervention on students' clinical learning outcomes: a randomized controlled trial

Running head: Effectiveness of mobile cooperation intervention

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Conflicts of interest

No conflict of interest has been declared by the authors.

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ABSTRACT-

Aims. To evaluate the effectiveness of the mobile cooperation intervention in improving the competence and self-efficacy of students and the quality of the clinical learning environment.

Background. For students, the clinical practicum is challenging as such and moreover the student – teacher cooperation, which supports the clinical learning of the students, has become complicated. Mobile applications have potential but their role in facilitating this cooperation remains unknown.

Design. A parallel-group randomized controlled trial.

Methods. Data were collected between January–March 2015 in Finland. The nursing students were randomly allocated to an intervention group (N = 52) or control group (N = 50). The intervention group used a mobile application to cooperate with the teacher during the clinical practicum. The control group engaged in standard cooperation. The primary outcome was competence. The secondary outcomes comprised self-efficacy and the quality of the clinical learning environment. Nurse Competence Scale, Self-efficacy in Clinical Performance instrument and the Clinical Learning Environment, Supervision and Nurse Teacher scale were used for student self-assessments. For the main analysis, hierarchical linear mixed models were used with the intention-to-treat principle.

Results. Competence and self-efficacy showed no significant between-group differences in mean improvements, but significant improvements in both groups were detected over the five weeks. Satisfaction with the clinical learning environment showed no significant between-group differences, however, the role of the teacher subscale, especially regarding cooperation, showed significant group-differences.

Conclusion. The mobile cooperation intervention was not significantly effective in improving individual outcomes, but did seem to improve significantly some aspects of the contextual outcomes.

Trial registration number: ClinicalTrials.gov: NCT02635295.

Keywords: clinical learning, clinical practicum, cooperation, mobile application, nurse teacher, nursing student, professional competence, randomized controlled trial, satisfaction, self-efficacy

SUMMARY STATEMENT

Why is this research or review needed?

- The role of nurse teachers in supporting clinical learning of students has faced changes and become complicated, hence new methods are needed to facilitate this cooperation.
- There is a lack of robust evidence on using the latest mobile technologies to support the clinical learning of students.

What are the key findings?

- No significant differences between the groups were detected with regard to any of the outcome measures that is, competence, self-efficacy and satisfaction with the clinical learning environment.
- Both cooperation methods significantly improved competence and self-efficacy, whereas the role of the teacher subscale, especially regarding cooperation, showed significant group-differences in favor of the intervention group.

How should the findings be used to influence policy/practice/research/education?

- Nursing education should consider using mobile cooperation intervention to solve challenges in the student – teacher cooperation during the clinical practicum.
- If the competence and self-efficacy of students wish to be supported more effectively, the App needs to be further developed and examined in RCT studies that have a longer intervention duration and longitudinal design.

INTRODUCTION

The clinical learning outcomes of nursing students (students) are critical in meeting the competence requirements of nursing workforce (Missen, McKenna, & Beauchamp, 2016a; Missen, McKenna, Beauchamp, & Larkins, 2016b; Salminen *et al*., 2010) and ensuring the delivery of safe and high-quality patient care (Aiken *et al*., 2011; 2014). The clinical practicum covers one half of the professional nursing studies (European Commission [EC], 2005, 2013a) and is vital in fulfilling the competence requirements for the future nursing workforce (EC, 2013a; European Federation of Nurses Associations [EFN], 2015; Nursing and Midwifery Council [NMC], 2010; Salminen *et al*., 2010; World Health Organization

[WHO], 2006). Previous studies have reported that graduating nursing students (GNSs) are lacking in relevant nurse competence (competence) when starting their nurse career (e.g. Missen *et al*., 2016a; 2016b). Student success in clinical learning is a key objective and ultimately the joint responsibility of the student, the nurse teacher (teacher) in higher education institutions (HEIs) and clinical practice mentors. Furthermore, registered nurses (RNs) heavy workloads, due to more acutely ill patients, shorter hospital stays and staffing shortages, limits their possibilities to supervise students' clinical learning. Thus, cooperation between students and their teacher is crucial, therefore an essential question is: how can the use of mobile technologies facilitate this cooperation?

Background

The cooperation between students and their teacher plays a central role alongside mentor supervision in meeting the multiple challenges of clinical learning (Gustafsson, Kullén Engström, Ohlsson, Sundler, & Bisholt, 2015; Papastavrou, Dimitriadou, Tsangari, & Andreou, 2016). This cooperation influences the competence (Lauder *et al.*, 2008b; Löfmark, Thorkildsen, Råholm, & Natvig, 2012; O`Connor & Andrews, 2015) and self-efficacy of students (Kenny, Van Neste-Kenny, Burton, Park, & Qayyum, 2012; Lauder *et al.*, 2008b; Rowbotham & Schmitz, 2013). Student self-efficacy predicts competence (Lauder *et al*., 2008b; Karabacak, Serbest, Öntürk, Aslan, & Olgun, 2013; Pijl-Zieber, Barton, Konkin, Awosoga, & Caine, 2014), the actual use of the competences as well as later success (Bandura, 1997, p. 237) and employee retention (Van Waeyenberg, Decramer, & Anseel, 2015) as RNs. Support from others, e.g. peers and teachers, is a key source in improving student self-efficacy (Bandura, 1997, p. 226, 234; Chesser-Smyth & Long, 2013; Lauder *et al*., 2008a). Hence, students consider teacher support an important clinical learning resource (Gustafsson *et al*., 2015; Papastavrou *et al*., 2016) but it is often unattainable (Gidman,

McIntosh, Melling, & Smith, 2011; Killam & Heerschap, 2013; Price, Hastie, Duffy, Ness, & McCallum, 2011).

Since the transfer of nursing education to HEIs in the early 1990s in Europe, the cooperation between students and teacher in promoting clinical learning (Löfmark *et al*., 2012; O´Connor & Andrews, 2015) has become complicated (Salminen *et al*., 2010) and conducted at a distance from the HEIs (Mikkonen, Elo, Miettunen, Saarikoski, & Kääriäinen, 2017; Saarikoski *et al*., 2013). It is evident, that there is no superior pedagogical method for this cooperation (Bloomfield, While, & Roberts, 2008; Forber *et al*., 2016; Gustafsson *et al*., 2015; Saarikoski *et al*., 2013). However, the existing methods do not match student needs for teacher support (Foster, Ooms, & Marks-Maran, 2014; Saarikoski *et al*., 2013) or take advantage of mobile technologies (O'Connor & Edwards, 2015; Strandell-Laine, Stolt, Leino-Kilpi, & Saarikoski, 2015).

Mobile technologies have potential for facilitating cooperation between students and teacher (Morley, 2014; Strandell-Laine *et al*., 2015) by enabling more interaction and a feeling of connectedness (Killam & Heerschap, 2013; Young *et al*., 2010) and support among students (Kenny *et al*., 2012; Morley, 2014). Research on such mobile cooperation, however, is scarce (O'Connor & Edwards, 2015; Strandell-Laine *et al*., 2015). Some promising evidence exists regarding mobile technologies and the benefits gained in bringing teachers closer to students in clinical learning, although there is a lack of rigorous evidence about the effectiveness of mobile cooperation in promoting clinical learning (McCutcheon, Lohan, Traynor, & Martin, 2015; O'Connor & Edwards, 2015; Strandell-Laine *et al*., 2015). Furthermore, there is a lack of research on the mobile applications developed for this cooperation (O'Connor & Edwards, 2015; Strandell-Laine *et al*., 2015).

More research is needed on the potential of mobile applications to facilitate cooperation between students and teacher to support clinical learning, especially because of the demands for digitalization made by HEIs (EC, 2013b; McCabe & Timmins, 2016) and the decrease in mentor and teacher commitment to clinical learning and concerns about existing and future RN shortages in Europe (Aiken *et al*., 2012; Flinkman, Leino-Kilpi, & Salanterä, 2010; WHO, 2015). Thus, a greater emphasis on supporting students during their clinical practicum is required. The purpose of this study is to examine whether cooperation between student and teacher with the aid of a mobile application will be effective in improving clinical learning outcomes, which refers to (1) individual outcomes, i.e. competence and self-efficacy of the students; and to (2) contextual outcomes, i.e. the quality of the clinical learning environment (CLE).

THE STUDY

Aim

The aim of this study was to evaluate the effectiveness of mobile cooperation intervention in improving the competence and self-efficacy of students and the quality of the CLE.

Hypotheses

Students in the intervention group will have a statistically significantly greater mean improvement over the study period in competence or self-efficacy or a statistically significantly higher satisfaction with the CLE compared with the control group.

Design

This complex mobile cooperation intervention study was conducted as a parallel-group randomized controlled trial (RCT) over three periods of five weeks during 2015 in southwest Finland. The study protocol has been described in detail (Strandell-Laine *et al*., 2017). This study was registered with the ClinicalTrials.gov identifier: NCT02635295.

Participants and setting

Students were primarily enrolled by the researcher (CS-L) at a university of applied sciences (UAS) in the pre-orientation lecture of the clinical practicum and as a protocol amendment by face-to-face conversations or phone calls until the target sample size was reached. The inclusion criteria for students were beginning a five-week internal medicine or surgical clinical practicum in one of the study hospitals, being at least a second-year pre-registration nursing student in the UAS and informed consent. Exclusion criteria were beginning the clinical practicum somewhere other than in one of the study hospitals, first year pre-registration nursing student, beginning a course other than a five week internal medicine or surgical clinical practicum or declining to participate. The study took place during the clinical practicum periods – arranged according to the curriculum in forty-two in-patient and out-patient surgical and internal medicine wards that provide extensive specialised health care services. These wards were situated across the seven hospitals of a hospital district, where approximately 1,500 clinical practicum periods are conducted annually.

Randomization and sample size calculation

Based on the assumption that a ten-point difference in the Nurse Competence Scale (Meretoja, Isoaho, & Leino-Kilpi, 2004) would be a significant improvement with standard deviation values of 17.7 (Kajander-Unkuri *et al*., 2014), a significance level of 0.05 (two-

tailed) and statistical power of 80%, at least 50 participants were required for each group. Randomization was on a 1:1 basis to either the intervention group (IG) or the control group (CG) by random permuted blocks (block size 6) conducted by computer-generated randomization codes and lists.

Intervention

Control group. Students in the CG engaged in standard cooperation, involving pre- and post-orientation lectures at the UAS and cooperation via email with the teacher, plus paper-based documentation during the clinical practicum.

Intervention group. Students in the IG engaged in mobile cooperation intervention. Its procedures were equivalent to standard cooperation; but conducted in the mobile application Study@Campus^{Pro} (App). The intervention included an App functionality training session, plus use of the App during the clinical practicum. The App included: (1) the documentation of the schedule of the clinical practicum shifts, learning objectives, a learning diary, mid-point and final evaluations; and (2) a social networking-style element for individual or group communication between students, teacher and mentors. The intervention was designed to facilitate cooperation between student and teacher by placing cooperation procedures in one central, digital environment, allowing flexibility and convenience and continuous use, enabling both synchronous and asynchronous cooperation independent of time and place. The App also enabled the teacher to control student documentation and offer feedback and support at appropriate times. The intervention was provided by both the teacher and a personal mentor, both of whom implemented the cooperation procedures according to the study protocol (Strandell-Laine *et al*., 2017). Teacher (CS-L) was the main intervention

provider; mentors received training in the App's functionalities and the intervention procedures.

Outcome measures

The primary outcome was competence, which was assessed using the generic Nurse Competence Scale, NCS (Meretoja *et al*., 2004). This instrument contains 73 items in seven subscales: helping role, teaching-coaching, diagnostic functions, managing situations, therapeutic interventions, ensuring quality and work role. Each item was assessed using a Visual Analog Scale (VAS) from 0 mm (very low-level competence) to 100 mm (very high-level competence). In this study, the internal consistency measured with the Cronbach's alpha was 0.96.

The secondary outcomes were self-efficacy and the quality of the CLE. Self-efficacy was assessed using the Self-Efficacy in Clinical Performance (SECP) instrument (Cheraghi, Hassani, Yaghmaei, & Alavi-Majed, 2009). This instrument contains 37 items in four subscales: assessment, diagnosis and planning, implementation and evaluation. Each item was assessed via an eleven-point Likert scale from 0 (totally disagree) to 10 (totally agree). In this study, the Cronbach's alpha was 0.98.

Quality of the CLE was assessed by means of student satisfaction with the CLE, using the Clinical Learning Environment, Supervision and Nurse Teacher scale, CLES+T_2 scale. The T-subscale, role of the nurse teacher, was further developed (Strandell-Laine *et al*., 2017) for this study from the original CLES+T scale (Saarikoski, Isoaho, Warne, & Leino-Kilpi, 2008) to assess the pedagogical cooperation between students and teacher and has five additional items related to ease of cooperation, teacher response time, relieving stress, promoting

learning and individual supervision. The CLES+T_2 scale contains 39 items in 5 subscales: pedagogical atmosphere, leadership style of the ward manager, premises of nursing on the ward, supervisory relationship and role of the teacher. Each item was assessed via a ten-point Likert scale from 1 (totally disagree) to 10 (totally agree). In this study, the Cronbach's alpha was 0.93.

Data collection

Data were collected with paper-based questionnaires January-March 2015. On the first day of the clinical practicum (baseline), students assessed their competence and self-efficacy and completed the demographic characteristics during a researcher-student face-to-face group meeting at the study hospital. At the end of the clinical practicum, students assessed their competence just before the final evaluation discussion to prevent it influencing the self-assessments. Students were asked to return these questionnaires in sealed envelopes to the researcher after the clinical practicum, when students assessed their self-efficacy and satisfaction with the CLE during a researcher-student face-to-face group meeting at the study hospital. The group meetings were arranged at a convenient time for the students.

Validity and reliability

The study was conducted by strictly following the study protocol (Strandell-Laine *et al*., 2017). The eligible volunteer participants were randomly allocated by the researcher after they had given their informed consent. Students in the IG and mentors, as intervention providers, received training in App functionalities and the intervention procedures. To maintain standardization, the same teacher cooperated with both groups during the study. All instruments were valid and reliable. The results of the study are reported in compliance with

the CONSORT 2010 Statement (Moher *et al*., 2012) in conjunction with the TIDieR checklist (Hoffmann *et al.*, 2014).

Ethical considerations

The study was approved by the University Research Ethics Committee (Statement 45/2014). Permission to conduct the study was obtained from the hospital district (T257/10/5.12.14) and the UAS (2014). Students who declined to participate conducted their clinical practicum according to the curriculum. Students and mentors received oral and written information before their written consent and prior to their allocation to IG or CG, about the purpose of the study and the option to withdraw at any point. The App was password protected to guarantee participant and patient confidentiality. The research data were stored in a server at the university and the paper documents were placed under lock and key by the first author.

Data analysis

The analysis followed the intention-to-treat principle (as randomized). All allocated participants were included in the analysis with no imputation of missing values. The baseline demographic characteristics were compared between the IG and CG using a Chi-square test or Fisher's exact (if needed) for categorical variables and the Mann-Whitney U-test for continuous variables due to their non-normal distribution.

The overall competence score was analyzed using hierarchical linear mixed models for repeated measures. Kenward-Roger correction was used for degrees of freedom and compound symmetry for covariance structure. The final model, with the whole study population, included group, time and group by time interaction testing whether the mean changes were different between the groups. In addition, age group (20–24 years, 25–30 years

and 31–38 years) and age group by time interaction were added to the model. Furthermore, gender, previous health care education, the students' self-assessed adequacy of regarding their theoretical knowledge before the clinical practicum (theoretical knowledge), the students' self-assessed adequacy of their practical skills before the clinical practicum (practical skills), the students' sense of fear at the beginning of the clinical practicum (also interactions with time) were tested but removed as they all were non-significant.

The overall self-efficacy was analyzed similarly to overall competence and all non-significant explanatory variables were removed from the model. The final model included group, time and group by time interaction. In the model, 95% confidence intervals were calculated to estimate the mean changes for both groups and each age group. The normality assumption was checked with studentized residuals. Satisfaction with the CLE was measured only at the end of the study and comparisons between IG and CG were made by Mann-Whitney U-test as many of subscale distributions were skewed. Overall satisfaction with the CLE score was approximately normally distributed and the multi-way analysis of variance with the model including group, theoretical knowledge and practical skills was tested and all non-significant explanatory variables (gender, previous health care education, prior working experience in social and health care) were removed.

Association between outcome variables (competence, self-efficacy and satisfaction with the CLE) were evaluated using two-way analysis of covariance where the model includes the group as a categorical explanatory variable and the corresponding sub-scores as a numerical explanatory variable. Cronbach's alpha was used to evaluate the internal consistency. The statistical significance level was set at *p*-value of 0.05 (two-tailed). The data were analyzed

using SAS version 9.4 for Windows software (SAS Institute Inc., Cary, NC, USA) or IBM SPSS Statistics version 23.0 for Windows software (IBM Corp., Armonk, NY, USA).

RESULTS

Demographic characteristics

A total of 102 participants were included in the study, of which 52 were randomly allocated to the IG and 50 to the CG (Figure 1). The majority of participants were female (N = 94, 92%), owned a smartphone (N = 99, 97%) and were under 25-years-old (70.6 %; median = 22.0, range = 20.0-38.0). There were no significant differences (all $p > 0.05$) in the demographic characteristics between the groups (Table 1). Most participants in the IG were active App users, for purposes related to the mobile cooperation, both at home (N = 49, 94%) and in the practicum ward (N = 48, 92%). Repeated App use, several times a day, was reported by seven (13%), while 29 (56%) reported using it several times a week. However, 15 (29%) participants used it only when needed and one (2%) refused it. Furthermore, 13 (25%) participants used a borrowed mobile device from the UAS, due to the small screen size of their own devices.

Competence

The overall competence showed no significant differences in mean improvements between the groups ($p = 0.57$), with a VAS score improvement of 10.11 (95% CI = 5.70–14.52, $t_{92.0}$ = 4.55) in the IG and 11.67 (95 % CI = 7.10–16.25, $t_{93.6} = 5.07$) in the CG. However, significant improvements in both groups were detected ($p < 0.001$). All seven subscales, except ensuring quality ($p = 0.14$), showed significant improvements (all $p < 0.014$) in both groups, with non- significant differences in the mean improvements in the subscales between the groups (all $p > 0.31$) (Table 2).

Based on the model constructed, age group was significantly associated with improvement in overall competence ($p = 0.035$). In the oldest age group (31–38 years), a significantly greater improvement of 17.63 (95 % CI 9.63–25.64, $t_{91.9} = 4.38$) in competence compared with the improvement of 6.22 (95 % CI 3.00–9.44, $t_{92.6} = 3.84$) in the youngest age group (20–24 years) was detected ($p = 0.010$). On the subscale level, age group showed a significant association with the improvement in managing situations ($p = 0.023$). In the oldest age group (31–38 years) a significantly greater improvement of 17.97 (95 % CI 7.86–28.08, $t_{73.4} = 3.54$) was found compared with the improvement of 2.87 (95 % CI 4.89–15.57, $t_{74.9} = 1.44$) in the youngest age group (20–24 years) ($p = 0.0071$).

Self-efficacy and satisfaction with the CLE

The overall self-efficacy showed no significant differences in mean improvements between the groups ($p = 0.37$), with an improvement of 1.77 (95 % CI 1.38–2.16, $t_{97.5} = 8.98$) in the IG and 1.51 in the CG (95 % CI 1.11–1.92, $t_{98.9} = 7.42$). However, significant improvements in both groups were detected ($p < 0.001$). All four subscales showed significant improvements ($p < 0.001$) in both groups, with non-significant differences in the mean improvements between the groups (all $p > 0.14$) (Table 3).

Based on the model constructed, there were no explanatory variables significantly associated with improvement in overall self-efficacy (all $p > 0.071$). On the subscale level, practical skills was significantly associated with the improvement in the assessment ($p = 0.019$): Students with very inadequate practical skills showed a significantly greater improvement of 4.75 (95 % CI 2.60–6.90, $t_{93.4} = 4.39$) in the assessment compared with those with more adequate practical skills with improvements ranging from 1.18 to 2.28 (all $p < 0.047$). Furthermore, theoretical knowledge was significantly associated with improvement in the

evaluation (p = 0.028): Students with very adequate theoretical knowledge showed a significantly greater improvement of 2.17 (95 % CI 1.62–2.73, $t_{95.8}$= 7.7) in evaluation compared with an improvement of 1.12 (95 % CI 0.66–1.59, $t_{95.6}$ = 4.77) among students with lower adequacy of theoretical knowledge (p = 0.0050). In addition, a significant strong positive association was found in both groups between overall competence and overall self-efficacy (β = 6.98, $t_{92.0}$ = 4.97, p < 0.0001). For subscales, only the implementation was significantly positively associated with overall competence (β =8.46, $t_{89.0}$ = 2.24, p = 0.028).

The overall satisfaction with the CLE showed no significant differences between the groups (p = 0.24) at the end of the study. However, the role of the nurse teacher subscale showed significantly higher overall scores in the IG (p = 0.0023) than in the CG and all other subscales measuring teacher cooperation with all the crucial actors in the students' clinical practicum showed significantly higher scores in the IG than in the CG (all p < 0.026) (Table 4).

Based on the model constructed, theoretical knowledge (p = 0.024) and practical skills (p = 0.019) were significantly associated with a higher overall satisfaction with the CLE. A significant decrease in the overall satisfaction with the CLE was associated with the lower adequacy of the students regarding theoretical knowledge and practical skills at the baseline (all p > 0.0001), both had the same decreasing trend from the overall satisfaction score of 8.13 (very adequate practical skills, 95 % CI 6.53–9.73, $t_{91.0}$ = 10.10) to 7.53 (adequate practical skills, 95 % CI 6.73–8.33, $t_{91.0}$ = 18.86). In addition, no significant association was found between overall competence and overall satisfaction with the CLE or the subscales of the CLES+T_2 (all p > 0.33).

DISCUSSION

There were no significant differences between the groups regarding any of the outcome measures. Nevertheless, our study reveals educationally significant findings. In both groups, a significant mean improvement in competence and self-efficacy was detected. On the subscale level, significant group-differences regarding satisfaction with the role of the teacher, especially regarding cooperation were detected. The constructed model showed student age, theoretical knowledge and practical skills to be significantly associated with improvements in the clinical learning outcomes; these findings are discussed below.

This is the first RCT using the NCS to evaluate the improvement of the competence of students during a clinical practicum period in the early stages of their nursing degree studies (Flinkman *et al*., 2017). It was expected that the novel and complex mobile cooperation intervention would show a statistically significantly greater mean improvement in students' competence compared with the CG, but this could not be proven. What is noteworthy in this study, is that significant improvements in overall competence detected similar increases for both groups. This finding is supported by studies on newly graduated nurses, NGNs (Delaney *et al*., 2015; Lima *et al*., 2016) and also reveals the desired and sufficient competence development during a single clinical practicum period.

Students' self-assessed competence is shown to be on a fairly high level in this study, but somewhat lower when compared with GNSs (Kajander-Unkuri *et al*., 2016; 2014) and NGNs' (Numminen *et al*., 2016) self-assessments with the NCS. In this study, both groups assessed themselves most competent in the helping role, which is deemed to be the core of the nursing care (Meretoja, Numminen, Isoaho, & Leino-Kilpi, 2015; Numminen, Leino-Kilpi, Isoaho, Meretoja, 2017). This corresponds with studies on GNSs (Kajander-Unkuri *et*

al., 2016; 2014) and NGNs (Hengstberger-Sims *et al*., 2008; Lima *et al*., 2016; Meretoja *et al*., 2015; Wangensteen, Johansson, Björkström, & Nordström, 2012).

Recent review by Flinkman *et al*. (2017) of studies using the NCS reported several variables associated with competence. In our study, we found only older age to be significantly associated with the improvement in the competence of both groups. Nevertheless, other studies have contradictory findings about this relationship. Meretoja *et al*. (2004) and Numminen *et al.* (2015; 2013) report a positive correlation between age and competence, while Lima *et al.* (2016) did not find this correlation with NGNs. In our study, the association between age and competence improvement might be explained by older students' greater experience, work life skills and motivation. These were not examined in our study and needs further research.

The self-assessed self-efficacy seemed to be on rather high level at the baseline in both groups supporting previous clinical practicum (Chesser-Smyth & Long, 2013; Jones & Sheppard, 2011) and nursing education studies (Lauder *et al*., 2008b). Self-efficacy showed a significant improvement in both groups, but there were no significant group-differences. This finding reveals the appropriateness of the pre-practicum education in preparing students with sufficient self-efficacy for meeting the challenges of clinical learning. Furthermore, a significantly greater self-efficacy improvement was detected in both groups with those students having either inadequate practical skills or adequate theoretical knowledge at the baseline compared with other students, but with a non-significant intervention effect. This is a notable finding that shows the importance of pre-practicum education in preparing students with sufficient theoretical knowledge while leaving the importance of learning practical skills

to the clinical area – where learning is conducted in contact with patients (Flott & Linden, 2016; Henderson, Cooke, Creedy, & Walker, 2012; Killam & Heerschap, 2013).

In our study, we detected significant improvements in overall competence and self-efficacy in both groups and a strong positive significant association between these two outcomes, especially in the implementation of the highest mean self-efficacy scores compared with the other subscales. These findings are in line with previous evidence from Lauder *et al.* (2008b) and Mohamadirizi *et al.* (2015) and they support Bandura's (1997) social cognitive theory, which regards self-efficacy as an indicator of a way of thinking and behaving. These findings might be explained by the students having relevant learning opportunities and successful completing the clinical practicum (Chesser-Smyth & Long, 2013). This may also reflect the students being exposed to clinical learning situations that are suitable for their theoretical knowledge and practical skills and which lead to feelings of being able to cope with clinical situations and new approaches (Bandura, 1997, p. 444). Thus, our study provides evidence to support the use of both cooperation methods in meeting the requirements of the nursing education and improving the students' expected clinical learning outcomes: self-efficacy (Chesser-Smyth & Long, 2013; Lauder *et al*., 2008b) and competence (EC, 2013a; EFN, 2015; NMC, 2010; Salminen *et al.,* 2010; WHO, 2006).

There were no significant group-differences regarding satisfaction with the CLE at the end of the study. However, students in the IG were significantly more satisfied with their teacher's role, especially with the teacher's cooperation, according to the statistics. Satisfaction with the teacher's pedagogical cooperation with students showed a higher median score in the IG compared with the other CLES+T_2 subscales in the IG regarding significant group-differences. This finding contrasts with previous studies, that report that students assess the

roles of teachers mainly positively but clearly at a lower level than the rest of the subscales of the CLES+T (Carlson & Idvall, 2014; Johansson *et al*., 2010; Saarikoski *et al*., 2013). The findings also reveal the intervention was successful in facilitating cooperation between students and teacher and generating the feeling that teacher support was available. Thus, the findings of this study confirm previous studies reporting improved feelings of connection (Killam & Heerschap, 2013), support (Kenny *et al*., 2012; Price *et al*., 2011), stress relief (Beauregard, Arnaert, & Ponzoni, 2017) and closeness to the teacher (Price *et al*., 2011; Saarikoski *et al*., 2013) when using mobile technologies in the clinical practicum. These are important findings as students face multiple challenges during the clinical practicum (Gidman *et al*., 2011) and expect support from the teacher in these challenges (Gustafsson *et al*., 2015; Killam & Heerschap, 2013; Price *et al*., 2011). Previous studies have reported that higher competence is related to increased student satisfaction with the CLE (Kajander-Unkuri *et al*., 2014) and received support (Kajander-Unkuri *et al*., 2014; Lauder *et al*., 2008a; 2008b; Löfmark *et al*., 2012; Morley, 2014; O`Connor & Andrews, 2015) but this study did not detect these associations.

This study provides evidence that the App, developed to facilitate cooperation between student and teacher, may be one solution to this complicated cooperation (Mikkonen *et al.*, 2017; Saarikoski *et al*., 2013; Salminen *et al*., 2010). Moreover, the App may change the method of documentation, providing a new information source for the curricula's development. One possible explanation for our findings might be that over half (56%) of the students in the IG reported using the App several times a week, which possibly improved cooperation with the teacher (Kenny *et al*., 2012; Wu, 2014) and increased satisfaction with this cooperation compared with the CG.

The intervention was complex (Craig *et al.*, 2013; Richards, 2015, p. 4) and required teacher cooperation with several students and mentors across several wards, requiring considerable planning and organization. Ultimately, the completion of the intervention was dependent on the students' and mentors' willingness and commitment to use new cooperation method. The strong motivation of performance during the intervention reveals that it is possible to implement the intervention, providing hope for its long-term future use. Although previous meta-analysis (Wu *et al.*, 2012) reveals that the majority of mobile learning studies (86%) show a significant intervention effect, our novel intervention did not success in this regarding any of the outcome measures. Effective methods to facilitate cooperation between students and teacher to support students' clinical learning are clearly needed. Thus, the App may need development with additional pedagogical elements for enabling more effective cooperation procedures to show favor of the IG. Moreover, a longer intervention duration, as suggested in the meta-analysis on the overall effectiveness of mobile devices in education (Sung, Chang, & Liu, 2016), may show significant intervention effect on the outcome measures.

Limitations

The intervention was implemented in one hospital district with students from one UAS. The heightened risk of between-group contamination and biased findings was minimized by the fact that the placements were spread across several wards and formal meetings between students were suspended for the duration of the clinical practicum. It was not possible to control the mentors' supervisory activities and different clinical learning situations because of the pragmatic design of the study. However, the supervisory relationship measured with the CLES+T_2 showed no significant group-differences and no important adverse events were observed, except minor technical problems with the learning diary and shift scheduling of the App, which were solved but may have caused frustration among the participants and delays

in the protocol-based cooperation procedures. The researcher was the main intervention provider, cooperating as a teacher for both groups, leading to a risk of researcher bias. The risk was minimised by strict protocol-based cooperation to ensure the standardization of the intervention implementation. Parts of the cooperation procedures were dependent on individual student activity causing possible variations in the amount of provided intervention. However, too strict and forced cooperation might have biased the findings, thus flexibility was left in the cooperation procedures because of the study's pragmatic design. Participant blinding was not achieved, although the statistician was blinded to the group allocation.

CONCLUSION

No significant group-differences were detected with regard to any of the outcome measures. The intervention had a significant effect on student satisfaction with the teacher's role, especially regarding cooperation, which reveals thus the intervention's educational value. Both cooperation methods significantly improved competence and self-efficacy, indicating that these may promote student success and employee retention during nursing degree studies and after graduation. These findings are valuable when considering the incorporation of the intervention into the nursing curricula, albeit it seems to be significantly effective in improving some aspects of the contextual outcomes, but not in improving the individual outcomes. If the individual outcomes are to be supported more effectively, the App needs to be further developed and its effectiveness should be examined in RCT studies that have a longer intervention duration and longitudinal design.

Author Contributions:

All authors have agreed on the final version and meet at least one of the following criteria (recommended by the ICMJE*):

1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data;

2) drafting the article or revising it critically for important intellectual content.

* http://www.icmje.org/recommendations/

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Table 1 Demographic characteristics of the students at the baseline.

	Total, n = 102	IG, n = 52	CG, n = 50	*p* value
Age, years median (range)	22.00 (20.00–38.00)	22.90 (20.00–37.00)	23.00 (20.00–38.00)	0.302*
20–24 years, *n (%)*	72 (70.6)	37 (71.2)	35 (70.0)	
25–30 years, *n (%)*	21 (20.6)	12 (23.1)	9 (18.0)	
31–38 years, *n (%)*	9 (8.8)	3 (5.8)	6 (12.0)	
Gender				
Female, *n (%)*	94 (92.2)	49 (94.2)	45 (90.0)	0.483
Male, *n (%)*	8 (7.8)	3 (5.8)	5 (10.0)	
Prior working experience in social and health care				
Yes, *n (%)*	32 (31.4)	16 (30.8)	16 (32.0)	0.531
No, n (%)	70 (68.6)	36 (69.2)	34 (68.0)	
Duration, months median (range)	13 (2.0–84.0)	18.0 (2.0–84.0)	12.0 (4.0–66.0)	0.102*
Number of the clinical practicum				
First, *n (%)*	5 (4.9)	4 (7.7)	1 (2.0)	0.384
Second, *n (%)*	44 (43.1)	24 (46.2)	20 (40.0)	
Third, *n (%)*	27 (26.5)	11 (21.2)	16 (32.0)	
Fourth, *n (%)*	26 (25.5)	25.0 (13)	13 (26.0)	
Clinical practicum				
Surgical, *n (%)*	61 (59.8)	31 (59.6)	30 (60.0)	1.000
Internal medicine, *n (%)*	41 (40.2)	21 (40.4)	20 (40.0)	
Theoretical knowledge before clinical practicum				
Very adequate, *n (%)*	0 (0.0)	0 (0.0)	0 (0.0)	0.386
Adequate, *n (%)*	37 (36.3)	16 (30.8)	21 (42.0)	
Neutral, *n (%)*	52 (51.0)	28 (53.8)	24 (48.0)	
Inadequate, *n (%)*	11 (10.8)	6 (11.5)	5 (10.0)	
Very inadequate, *n (%)*	2 (2.0)	2 (3.8)	0 (0.0)	
Practical skills before clinical practicum				
Very adequate, *n (%)*	2 (2.0)	1 (1.9)	1 (2.0)	0.316
Adequate, *n (%)*	11 (10.8)	7 (13.5)	4 (8.0)	

Neutral, *n (%)*	63 (61.8)	27 (51.9)	36 (72.0)	
Inadequate, *n (%)*	24 (23.5)	16 (30.8)	8(16.0)	
Very inadequate, *n (%)*	2 (2.0)	1 (1.9)	1(2.0)	
Sense of fear before clinical practicum				
Very much, *n (%)*	6 (5.9)	2 (3.8)	4 (8.0)	0.801
Much, *n (%)*	17 (16.7)	9 (17.3)	8 (16.0)	
Neutral, *n (%)*	29 (28.4)	17 (32.7)	12 (24.0)	
Little, *n (%)*	42 (41.2)	20 (38.5)	22 (44.0)	
Very little, *n (%)*	8 (7.8)	84 (7.7)	4 (8.0)	
Smartphone in own use, *n (%)*	99 (97.1)	49 (94.2)	50 (100)	0.243

IG, intervention group; CG, control group; SD, standard deviation. *P*-values are calculated between the total IC and CG.

Continuous variables tested with the Mann-Whitney U-test*. Categorical variables tested with Fisher's exact or Chi-square test.

Table 2 Improvements in self-assessed competence in IG and CG.

	Baseline		After 5 weeks		Improvement over 5 weeks			
	IG	CG	IG	CG	IG	CG		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	*p*	*p*
Sub-scale	range	range	range	range	95% CI	95% CI	Time	Group∗time
Helping role	48.77 (11.66)	51.16 (14.44)	56.47 (13.98)	57.24 (18.71)	8.80 (2.25)	7.35 (2.29)	<0.001*	0.60
	23.57 to 75.43	31.43 to 91.14	14.00 to 83.50	16.86 to 91.17	4.32 to 13.26	2.82 to 11.89		
Teaching-coaching	39.30 (16.17)	37.19 (17.21)	45.38 (17.81)	44.05 (22.40)	7.88 (2.81)	10.41 (2.87)	<0.001*	0.45
	4.94 to 81.80	15.13 to 83.67	2.56 to 68.63	8.94 to 86.13	2.30 to 13.47	4.70 to 16.12		
Diagnostic functions	40.39 (19.89)	42.52 (20.63)	45.04 (18.44)	45.75 (24.43)	5.84 (3.11)	6.72 (3.18)	0.014*	0.82
	4.29 to 79.71	15.50 to 80.57	5.86 to 89.00	10.86 to 89.75	-0.34 to 12.02	0.40 to 13.04		
Managing situations	35.15 (18.48)	38.03 (19.96)	40.01 (20.44)	43.10 (23.21)	10.23 (2.68)	8.39 (2.89)	<0.001*	0.58
	2.00 to 72.00	3.75 to 85.80	2.38 to 74.40	3.25 to 80.00	4.89 to 15.57	2.64 to 14.13		
Therapeutic interventions	31.12 (19.04)	30.98 (19.54)	35.09 (18.62)	36.88 (23.55)	5.38 (3.44)	9.53 (3.60)	0.012*	0.31
	2.80 to 75.50	9.40 to 77.63	2.50 to 69.40	4.00 to 79.00	-1.49 to 12.25	2.35 to 16.70		
Ensuring quality	36.16 (19.97)	41.50 (20.02)	38.82 (21.74)	45.30 (22.61)	3.52 (3.39)	4.86 (3.44)	0.14	0.73
	4.00 to 79.17	3.17 to 82.50	7.00 to 79.67	2.33 to 86.00	-3.21 to 10.26	-1.97 to 11.70		
Work role	36.97 (19.66)	36.05 (19.58)	44.81 (21.37)	40.92 (20.73)	10.00 (2.73)	8.47 (3.39)	<0.001*	0.68
	3.16 to 78.91	9.21 to 88.55	5.84 to 74.71	6.63 to 80.64	4.53 to 15.46	1.71 to 15.23		
Overall mean	38.52 (16.09)	40.93 (17.32)	45.55 (18.15)	49.23 (21.79)	10.11 (2.22)	11.67 (2.30)	<0.001*	0.57
	6.30 to 73.22	5.16 to 73.26	14.84 to 82.41	8.05 to 85.56	5.70 to 14.52	7.10 to 16.25		

Time *p*-value displays the mean improvement of VAS scores over 5 weeks, Group ∗ time *p*-value indicates whether the mean improvements of the VAS scores are

different between IG and CG. IG, intervention group; CG, control group; SD, standard deviation. Number of subjects varied between sub-scales and timepoints; at baseline: IG (n=44–52), CG (n=36–49); after 5 weeks: IG (n=42–52), CG (n=26–47).

*Statistically significant *p*-value <0.05 (two-tailed).

Table 3 Improvements in self-assessed self-efficacy in IG and CG.

Sub-scale	Baseline		After 5 weeks		Improvement over 5 weeks			
	IG (n=52) Mean (SD) range	CG (n=50) Mean (SD) range	IG (n=50) Mean (SD) range	CG (n=48) Mean (SD) range	IG Mean (SD) 95% CI	CG Mean (SD) 95% CI	*p* Time	*p* Group * time
Assessment	5.42 (1.80) 1.58 to 8.33	5.70 (1.64) 1.58 to 8.75	7.22 (1.14) 4.29 to 9.17	7.07 (1.63) 3.08 to 9.50	2.49 (0.36) 1.79 to 3.20	2.07 (0.37) 1.34 to 2.81	<0.001*	0.19
Diagnosis and planning	4.61 (1.85) 1.33 to 8.11	4.68 (1.71) 1.33 to 8.11	6.44 (1.47) 2.67 to 8.56	6.48 (1.90) 2.00 to 9.22	1.85 (0.25) 1.36 to 2.35	1.85 (0.26) 1.34 to 2.36	<0.001*	0.99
Implementation	6.04 (1.51) 4.65 to 8.50	6.21 (1.46) 2.90 to 8.50	7.68 (1.03) 5.50 to 9.30	7.49 (1.41) 3.10 to 9.80	2.15 (0.31) 1.54 to 2.76	1.75 (0.32) 1.12 to 2.38	<0.001*	0.14
Evaluation	4.31 (1.66) 1.17 to 8.00	4.44 (1.64) 1.50 to 8.00	6.10 (1.49) 2.50 to 8.33	5.86 (1.00) 1.17 to 9.50	1.90 (0.36) 1.19 to 2.61	1.47 (0.40) 0.68 to 2.26	<0.001*	0.21
Overall mean	5.21 (1.61) 1.86 to 7.95	5.38 (1.49) 2.08 to 8.41	6.98 (1.15) 4.32 to 8.78	6.85 (1.60) 2.68 to 9.19	1.77 (0.17) 1.38 to 2.16	1.51 (0.20) 1.11 to 1.92	<0.001*	0.37

Time *p*-value displays the mean improvement over 5 weeks and Group * time *p*-value indicates whether the mean improvements are different between the IG and CG. IG, intervention group; CG, control group; SD, standard deviation.

*Statistically significant *p*-value <0.05 (two-tailed).

Table 4 Student satisfaction with the CLE in IG and CG after 5 weeks.

	IG		CG			
Sub-scale	Median	Q_1, Q_3	Median	Q_1, Q_3	*p* Group	Cronbach α
Pedagogical atmosphere	8.11	6.61, 8.94	8.56	7.61, 9.33	0.085	0.92
Leadership style of the ward manager	7.13	6.00, 8.25	8.00	6.25, 8.88	0.059	0.89
Premises of the nursing on the ward	7.75	6.75, 8.75	8.25	7.63, 8.75	0.033*	0.81
Supervisory relationship	9.00	7.88, 9.63	9.25	8.31, 9.75	0.26	0.97
Role of the nurse teacher	7.70	5.79, 8.36	5.86	4.68, 7.46	0.0023*	0.92
Nurse teacher as enabling the integration of theory and practice	7.33	6.00, 8.33	7.00	5.00, 7.00	0.17	0.90
Cooperation between placement staff and nurse teacher	6.00	4.00, 7.50	4.00	2.00, 6.67	0.0012*	0.85
Relationship among student, mentor and nurse teacher	7.67	4.33, 8.83	4.67	1.00, 8.00	0.016*	0.98
Nurse teacher's pedagogical cooperation with students	8.80	7.60, 9.60	7.90	6.30, 9.00	0.026*	0.88
Overall mean**	7.81	7.00, 8.44	7.53	6.63, 8.26	0.24	0.93

Group *p*-value indicates whether there is a difference between IG and CG. IG, intervention group; CG, control group; Q_1, Q_3, lower and upper quartiles. Number of subjects varied between sub-dimensions; IG (n=52), CG (n=47–48).
*Statistical significant *p*-value <0.05 (two-tailed).
**Mean score of all responses regarding the CLES+T_2 items.

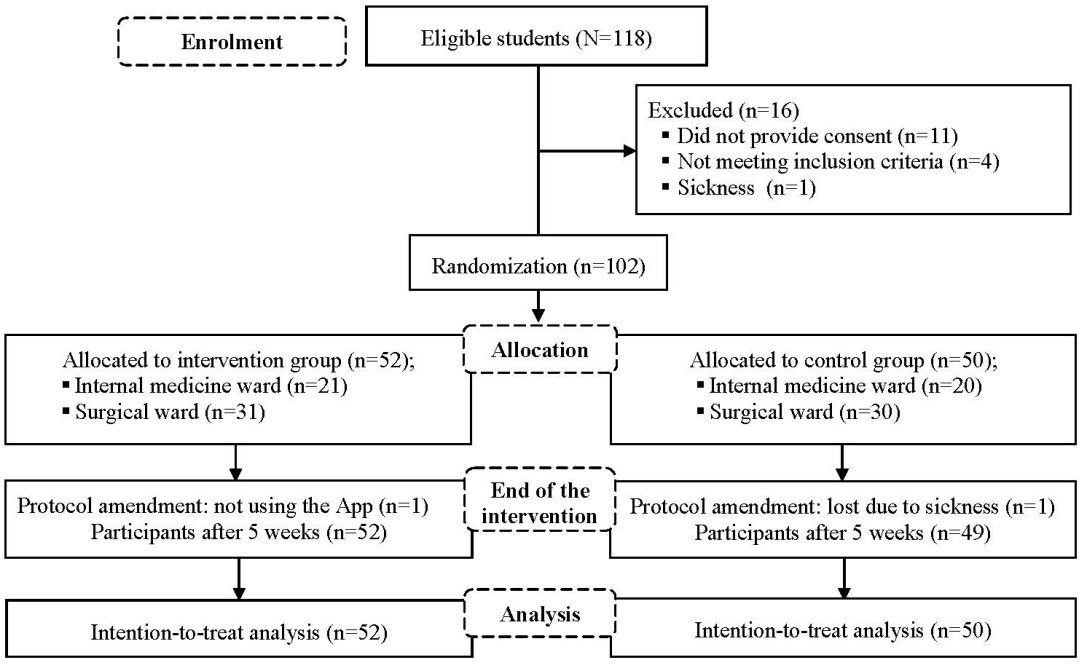

Figure 1 Student participant flowchart through the study