



## A process evaluation of a mobile cooperation intervention: A mixed methods study



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### ABSTRACT

**Background:** A mobile cooperation intervention was developed to facilitate the cooperation of nursing students with nurse teacher and to improve the students' clinical learning outcomes. The intervention consisted of training in a mobile application's functionality and its use during clinical practicum cooperation procedures.

**Objectives:** To describe the development of a mobile application for student-teacher cooperation and to examine the acceptability of the mobile cooperation intervention for advancing intervention development.

**Design:** A user-centred design and a mobile application development lifecycle model were applied to develop a mobile application. A process evaluation that used mixed methods design was conducted within the intervention group after a randomized controlled trial of a complex mobile cooperation intervention.

**Setting:** The clinical practicum wards of seven hospitals in a hospital district in Finland.

**Participants:** Second-year pre-registration nursing students (N = 52) from one nursing school.

**Methods:** Process evaluation questionnaires were completed upon completion of the five week intervention and essays were written by the students eleven weeks after the intervention ended.

**Results:** A system usability scale (SUS) assessed the overall usability of the mobile application as rather good (a mean SUS score of 69.86 out of 100). Positive feedback about the mobile application's usability and utility was reported and recommendations for further development were highlighted. The intervention demonstrated high acceptability. In general, the students actively used the mobile application for intervention procedures at home and in the clinical practicum ward.

**Conclusions:** The findings support the high acceptability of mobile cooperation intervention and its potential while also providing evidence for the development team's future development of the mobile application. Additionally, this study provides an example of mobile application development and process evaluation in nursing education research.

## 1. Introduction

Nursing students' (students') clinical learning in Finland is increasingly supervised from higher education institutions (HEIs) and is aided by nurse teachers' (teachers') distance cooperation methods. However, students face challenges in this cooperation as there is only limited access to computers in the practicum wards (Colton and Hunt, 2016; Johansson et al., 2013; Roberts and Williams, 2017), leading to feelings of isolation and the loss of teacher support (Killam and Heerschap,

2013; Pimmer et al., 2018; Price et al., 2011). Thus, there is need for new methods that can enable flexibility, closeness, convenience and the hands-on-use of students' mobile devices to facilitate the student-teacher cooperation.

## 2. Background

Mobile devices – like smartphones, tablet computers, watches, portable computers and the mobile applications that can be used on

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them – are increasingly used in clinical practicums (Lee et al., 2018; Raman, 2015; Roberts and Williams, 2017; Strandell-Laine et al., 2015). The use of these technologies has resulted in findings of great promise but the benefits of these technologies have yet to be fully utilised (Roberts and Williams, 2017; Strandell-Laine et al., 2018). The previous literature shows the potential for the use of mobile technologies in student-teacher cooperation with regard to improving students' clinical learning experiences by increasing the frequency (Wu, 2014), privacy, support (Roberts and Williams, 2017) and ease (Beauregard et al., 2017; Doyle et al., 2014; Strandell-Laine et al., 2015) of such cooperation. To address the challenges facing student-teacher cooperation described above and explore the promising findings of mobile technology use for aiding that cooperation, a complex mobile cooperation intervention (MCI) – specifically aimed at improving students' clinical learning outcomes – was developed to facilitate student-teacher cooperation. A parallel-group randomized controlled trial (RCT) was conducted to evaluate the effectiveness of the MCI. This comprised the use of the newly developed mobile web application (Study@Campus<sup>Pro</sup>, hereinafter App) and training in the App's functions. Promisingly, the MCI was shown to have a significant intervention effect on student satisfaction with student-teacher cooperation, whereas a non-significant intervention effect on the students' self-assessed competence, self-efficacy or satisfaction with the clinical learning environment was detected (Strandell-Laine et al., 2018). In addition to evaluating the effectiveness, another important factor in complex interventions with multiple interacting components, organisations and outcome measures (Craig et al., 2013; Strandell-Laine et al., 2017) remains the understanding of the process. Moreover, there is a lack of literature on systematic mobile application development that applies usability testing in the field of nursing education. Thus, for this study, the App's development is described with reference to a process evaluation of the MCI that aimed to examine how the students accepted the MCI. The main trial is registered in [ClinicalTrials.gov](https://clinicaltrials.gov) by the identifier: NCT02635295. The protocol for the trial of the MCI (Strandell-Laine et al., 2017) and the evaluations of the outcomes (Strandell-Laine et al., 2018) are reported elsewhere.

### 3. Methods

#### 3.1. App development and description

The App's development was guided by the mobile application development lifecycle model (MADLC) by Vithani and Kumar (2014), which generates a systematic approach for the development of mobile applications. In addition, user-centred design (Gulliksen et al., 2003) was applied to develop a user-friendly mobile application to meet the needs and expectations of the end-users. The development is described below according to the MADLC, using the first five phases of the MADLC's seven – in which the output of the previous phase provides the base for the next phase.

Based on the integrative review undertaken (Strandell-Laine et al., 2015) during the *Identification Phase (I)*, no mobile application was found to have been specifically developed for student-teacher cooperation. Therefore, the need existed for the development of a tailored and novel mobile application for student-teacher cooperation that would facilitate easy and ubiquitous hands-on cooperation during the clinical practicum. In the *Design phase (II)*, a multidisciplinary design team of nurse teacher, nursing education researcher (C S-L) and software developers developed the App's initial design through group discussions, several rounds of feedback and the modification of the App. The App was developed as a module for a wider system. The graphical user interface (GUI), consisting of the screen view and the flow of the App, was designed to be simple to facilitate its ease-of-use in the busy practicum wards (Colton and Hunt, 2016; Martyn et al., 2014). Thus, the GUI includes one-touch navigation for its four main components: (1) *the learning diary component* allows students to write about a specific

day and to delete the written text; (2) *the objectives and evaluation component* allows students to read the curriculum-based course-specific objectives, to write and edit their individual learning objectives, mid-point and final evaluations; (3) *the practicum shift component* allows students to enter, plan and report daily practicum hours and write notes about a specific day. In addition, this component provides automatic feedback on the planned weekly and total practicum hours for the period; (4) *the social networking component* enables students to cooperate with their mentor, teacher and peers through one-to-one or group discussions. All App users have their own user accounts and access only the data they need. The mentors and the teacher have access to the documents of the students they are supervising and are able to give them feedback on all components, except for individual student-student cooperation in the social networking component. The App's components are based on the general clinical practicum supervision and documentation procedures in Finland. The App was designed to facilitate student-teacher cooperation and to provide additional features that are not possible or more time consuming when using email-based cooperation and paper-based documentation (Saarikoski et al., 2013). These additional features include the automatic calculation of the practicum hours, notifications about the deadlines for the student evaluation sessions and the enabling of automatic data storing and sharing between the student, mentor and teacher. The App components for the mentors' supervision procedures were not examined in this study, although the need for such study has been reported (Colton and Hunt, 2016).

In the *Development Phase (III)*, the App was coded by the software development team and the GUI was designed to be responsive and support any browser and device. In the *Prototyping Phase (IV)*, the App's prototype was given to a purposefully selected sample of teacher (n = 1, C S-L) and second-year pre-registration nursing students (n = 6) for their feedback. Their evaluation took place after the App had been used to facilitate student-teacher cooperation during a 5-week clinical practicum that took place in different wards, thus representing the actual environments for which the App was designed. This formative usability testing (Barnum, 2011, p.14) was conducted to gather feedback from the end-users and to inform the development team about any possible problems regarding the functionality of the App. Based on the feedback, minor changes were made to the GUI to utilise the maximum amount of screen available. In the *Testing Phase (V)*, summative usability testing was conducted (Barnum, 2011, p.111). This testing phase is the key aspect in the MADLC (Vithani and Kumar, 2014) and was conducted alongside the main trial, informing the process evaluation of the MCI, which is described in more detail below.

#### 3.2. Design of the process evaluation

A process evaluation that used a mixed methods design, according to Medical Research Council (MRC) guidance for the process evaluation of complex interventions (Moore et al., 2015), was conducted after the completion of the main trial. The process evaluation was conducted from the perspective of the students. The aim of the process evaluation was to examine the acceptability of the MCI by retrospectively exploring students' commitment to and experiences with the MCI and to identify areas in which the App could be improved and further developed.

#### 3.3. Participants and setting

The participants were second-year pre-registration nursing students (N = 52) from a Finnish nursing school conducting their surgical or internal medicine clinical practicum (in Finland, nursing students are taught within universities of applied sciences, UAS) in spring 2015. The participants represented the end-users of the App and the intervention recipients in the main trial. The study was conducted across highly specialized wards of seven hospitals in a hospital district in Finland.

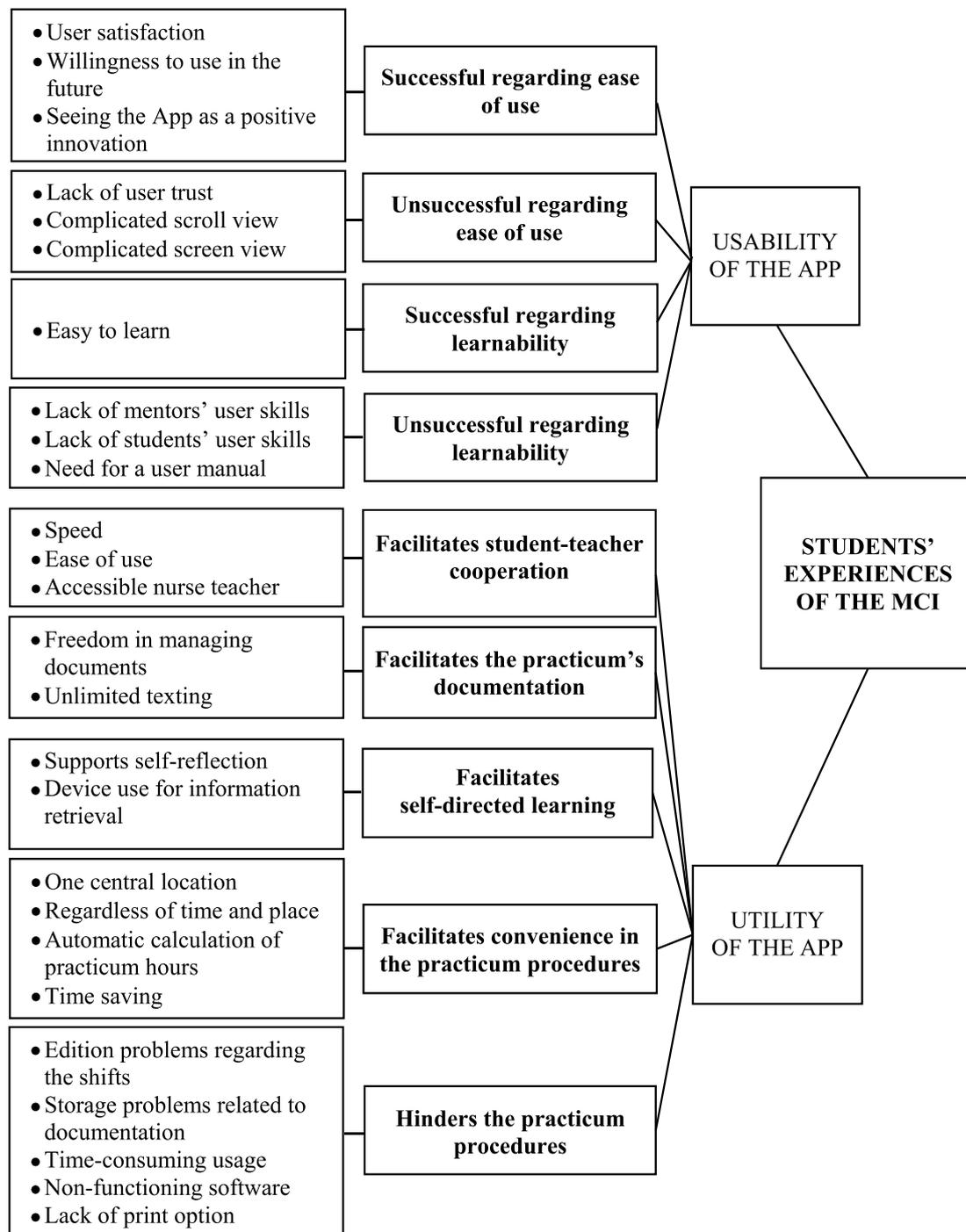


Fig. 1. Students' experiences of the MCI based on the essays (n = 10).

### 3.4. Procedures

Ethical approval was obtained from the University Research Ethics Committee (Statement 45/2014). The research permissions were obtained from the nursing school (2014) and the study hospital district (T257/10/5.12.14). All participating students gave their written informed consent before entering the study. On the first day of the clinical practicum, the students received their own passwords and usernames for the App, 20 min functionality training in using the App and the researcher presented the tasks to be performed with the App during the MCI (Strandell-Laine et al., 2017). The students' participation in this study included tasks in which they used the final prototype of the App to conduct cooperation procedures during the 5-week MCI. The

students used the App on their personal mobile device or on a loaned device from the nursing school, enabling testing to occur on several operating systems and on mobile devices with different screen sizes (Vithani and Kumar, 2014).

### 3.5. Data collection

The data were collected from students at two different time points and through process evaluation questionnaires and essays. The development of the questionnaire and essay topics were based on Medical Research Council (MRC) guidance for the process evaluation of complex interventions (Moore et al., 2015), previous literature (Strandell-Laine et al., 2015) and the MCI procedures of the student-teacher cooperation

(Strandell-Laine et al., 2017). The process evaluation questionnaires were completed by the students in a researcher-student face-to-face meeting at the study hospitals upon completion of the MCI. The first part of the questionnaire had structured questions specifically developed for this study with regard to the students' commitment to the MCI and their experiences of the MCI – as measured by the students' App usage. The second part of the questionnaire included the System Usability Scale, SUS (Brooke, 1996, p.192), which was used to measure the perceived general usability the App from the perspectives of the end-users. The SUS is freely available and widely used as it has good psychometric properties. The SUS uses a five-point Likert Scale from 1 to 5 (strongly disagree-strongly agree) with a total of 10 items (Table 5) covering two dimensions: perceived learnability (items 4, 10) and perceived usability (items, 1–3, 5–9). The SUS provides a single reference score ranging from 0 to 100 (the worst-the best) and the average SUS score is 68 (Brooke, 2013). The second part took place 11 weeks after the intervention ended when all the students were asked to write an essay in their own time about their experiences of the MCI and with particular reference to the benefits, development recommendations and other issues they wanted to consider regarding the App and MCI as a whole. The students were asked to write and send the essays by email to the researcher within one week to minimize any possible pressure and influence from other students.

### 3.6. Data analysis

The SUS items were scored before the analysis by the Brooke system (Brooke, 2013), leading to item contributions ranging from 0 to 4 (the most negative response-the most positive response). The mean SUS score comparisons between the categories of the different explanatory variables were conducted by a Kruskal-Wallis test that was then continued with Steel-Dwass multiple comparisons (Tables 2, 4, 6). The quantitative data were analysed using the SAS version 9.4 for Windows software (SAS® Institute Inc., Cary, NC, USA). The level of statistical significance was set at a *p*-value of 0.05 (two-tailed).

Two researchers (Mst, C S-L) independently analysed the essays by an inductive approach using thematic analysis, which offers flexibility in analysing data independent of the theoretical and epistemological approaches (Braun and Clarke, 2006). Firstly, the data were read and re-read to gain familiarity with the data. Secondly, the initial codes of the data were identified and grouped into potential sub-themes on a thematic map. Thirdly, the themes were reviewed and the final names for each theme were generated. The analysis of the essay data led to the identification of two main themes and nine subthemes (Fig. 1, Table 1).

## 4. Results

### 4.1. Demographic characteristics

Students were predominantly female and aged between 20 and 37 years (94.4%) and owned at least one mobile device (98.0%). Based on the students' own evaluations, they had very good or good technology literacy (86.6%) and frequently use their mobile devices every day (88.4%). A more detailed description of the students' demographic characteristics, collected at the baseline of the main trial, are presented in Table 2.

**Table 1**

Examples of the thematic data analysis process.

Data extract	Coded for	Sub-themes	Main themes
"It was easy to get in contact with the teacher and cooperation with the teacher was much quicker and handier" (S4)	Speed	Facilitates student-teacher cooperation	Utility of the App
"Hopefully the application will also be in use in the future" (S2)	Willingness to use in the future	Successful regarding ease of use	Usability of the App

**Table 2**

Students' demographic characteristics (N = 52) and SUS scores for the demographic variables.

Participant demographics	Variables	n (%)	SUS scores		
			Mean	SD	<i>p</i> -Value
Age, years, median (range)		22.9 (20.0–37.0)			
Age groups					.739
	20–24 years	37 (71.2)	69.05	20.32	
	25–30 years	12 (23.1)	74.25	19.37	
	31–38 years	3 (5.8)	67.00	20.42	
Gender					
	Female	49 (94.2)	85.00	10.00	.146
	Male	3 (5.8)	68.93	20.02	
Clinical practicum					
	Surgical	31 (59.6)	65.08	20.94	.040*
	Internal medicine	21 (40.4)	76.90	16.22	
Mobile device in own use					
	Smartphone and tablet computer in own use	15 (28.8)	67.00	23.49	.609
	Only smartphone in own use	34 (65.4)	70.44	18.74	
	Only tablet in own use	2 (3.8)	85.00	14.14	
	No mobile device in own use	1 (1.9)	62.50	NA	
Utilisation of the mobile device use in studies					
	For finding information	49 (94.2)	70.20	20.34	.376
	To cooperate with peers	50 (96.2)	70.00	20.26	.567
	To cooperate with the nurse teacher	31 (59.6)	67.50	22.10	.495
	For e-learning	39 (75.0)	71.28	20.51	.216
	For other purposes	8 (15.4)	62.50	24.28	.316
Daily mobile device usage					
	Several times an hour	14 (26.9)	64.11	23.20	.483
	Several times a day	32 (61.5)	72.66	19.78	
	Couple of times a day	5 (9.6)	67.00	8.18	
	No daily use	1 (2.0)	75.00	NA	
Perception of own mobile technology literacy level					
	Very good	16 (30.8)	72.03	21.47	.061
	Good	29 (55.8)	73.62	15.88	
	Neutral	5 (9.6)	49.00	24.66	
	Poor	2 (3.8)	50.00	17.68	
	Very poor	0 (0.0)	NA	NA	
Perception of need to increase mobile technology use in nursing education					
	Yes	22 (42.3)	70.91	23.51	.185
	No	7 (13.5)	59.29	15.53	
	Neutral	23 (44.2)	72.07	16.78	

SD = standard deviation; NA = not available.

\* Statistically significant *p*-value < .05 (two-tailed).

### 4.2. Students' commitment to the MCI

For the main trial, 52 students were randomly allocated to the intervention group and all completed the initial App functionality training. The students had a very strong commitment to the MCI in terms of their high usage of the App during the MCI procedures (Table 3). One student refused to use the App but did not give a reason. Roughly three-quarters of the students (76.9%) reported only using the App during the cooperation procedures. A quarter of students (25.0%)

**Table 3**  
Students' commitment to the MCI procedures (N = 52).

Variables	Yes n (%)	No n (%)
Participation in functionality training for the App	52 (100.0)	0 (0.0)
Documentation of individual learning objectives in the App	51 (98.1)	0 (0.0)
Documentation of practicum shifts in the App	46 (88.5)	5 (9.6)
Documentation of the individual midpoint evaluation in the App	41 (78.8)	10 (19.2)
Documentation of the individual final evaluation in the App	41 (78.8)	10 (19.2)
Cooperation with teacher via the App <sup>a</sup>	46 (88.5)	4 (7.7)
Cooperation with peers via the App	2 (3.8)	49 (94.2)

used the App on a tablet computer purchased from the nursing school. The students used the App both at home (94.4%) and in the practicum ward (92.3%) and reported using it several times a week on a good wireless connection (Table 4). All the students completed the process evaluation questionnaire and ten essays were returned after the MCI.

4.3. Students' experiences with the MCI

Half of the students (50.0%) took the initial functionality training for the App and almost all (90.3%) rated the technical support given

**Table 5**  
SUS scores of the App (N = 52).

SUS items, ranging from 0 to 4.	Mean	SD
1. I think that I would like to use this App frequently	2.50	1.26
2. I found this App to be simple	2.85	1.09
3. I thought this App was easy to use	2.87	1.16
4. I think that I could use the App without the support of a technical person	3.10	1.21
5. I found the various functions in this App were well integrated	2.38	1.09
6. I thought there was a lot of consistency in this App	2.79	1.09
7. I would imagine that most people would learn to use this App very quickly	3.04	0.99
8. I found this App very intuitive	2.79	1.30
9. I felt very confident using this App	2.58	0.98
10. I could use the App without having to learn anything new	3.06	1.11

SD = standard deviation.

during the intervention as adequate. More than two-thirds of the students (69.3%) reported a positive attitude regarding their usage of the App in the MCI.

The usability of the App was reported to be rather good. The mean SUS score was 69.86 (Standard deviation, SD 19.89, range 10.00–97.50). For learnability items, the perception of being capable to use the App without the support of a technical person (item 4), showed the highest mean score (3.10, SD 1.21). For usability items, the

**Table 4**  
Students' App usage in the MCI (N = 52) and SUS scores for App usage variables.

Variables	Usage of the App		SUS score		
	n (%)	Mean	SD	p-Value	
App functionality training before the MCI				.003*	
Adequate	38 (50.0)	75.72	16.45	.017**	
Neutral	9 (17.3)	57.50	16.68		
Inadequate	5 (9.6)	47.50	26.22		
Technical support in App usage during the MCI				.019*	
Adequate	47 (90.3)	72.98	17.05		
Neutral	4 (7.7)	48.13	17.00		
Inadequate	1 (1.9)	10.00	NA		
Wireless connection during the App usage				.056	
Good	42 (80.7)	72.86	19.17		
Neutral	3 (5.8)	55.00	22.91		
Poor	5 (9.6)	53.00	19.72		
The mobile device					
Own mobile device	39 (75.0)	69.94	20.60	.751	
Borrowed mobile device	13 (25.0)	69.42	17.44	.619	
App usage in the MCI				.033*	
Only the App	40 (76.9)	73.50	17.29		
App and other cooperation methods	12 (23.1)	57.71	23.75		
Frequency of student usage of the App <sup>a</sup>				.014*	
Several times in an hour	0 (0.0)	NA	NA		
Several times in a day	7 (13.5)	80.36	13.73		
Several times in a week	29 (55.8)	72.50	21.66		
If needed	15 (28.8)	60.00	15.73		
Place of App usage					
In the practicum ward	48 (92.3)	70.21	20.07	.630	
At home	49 (94.2)	69.49	20.38	.496	
In public places (e.g. café, library, bus)	9 (17.3)	73.06	18.53	.629	
Student's own attitude to using the App				<.001*	
Positive	36 (69.3)	77.64	15.86	<.001**	
Neutral	14 (26.9)	54.82	16.51		
Negative	2 (3.8)	35.00	7.07		
Student's view of mentor attitudes to using the App				.033*	
Positive	25 (48.1)	75.80	17.33		
Neutral	16 (30.8)	71.56	13.22		
Negative	11 (21.1)	53.86	25.67		

SD = standard deviation; MCI = mobile cooperation intervention; NA = not available; <sup>a</sup> = missing participant (n = 1).

perception that most people would learn to use the App very quickly (item 7), presented the highest mean score (3.04, SD 0.99). (Table 5.) The mean SUS score showed to be statistically significantly higher ( $p = .040$ ) for students in the internal medicine practicum (mean 76.90, SD 16.22) rather than in the surgical practicum (mean 65.08, SD 20.94) (Table 2). In addition, students who reported that the App functionality training was adequate ( $p = .017$ ) and who had a positive attitude to using the App ( $p \leq .001$ ), had a statistically significantly higher mean SUS score compared to those with neutral responses in the respective variables (Table 4).

For the essays, most of the students wrote about their satisfaction with their App usage regarding the MCI. Students were willing to use the App in the future and this was seen as a positive innovation for nursing education. However, some of the students reported difficulties in using the App because the GUI did not scroll as desired. In addition, a lack of trust concerning privacy with regard to the social networking component was expressed. Overall, most of the students experienced the App as easy to learn, nevertheless a lack of both student and mentor skills in using the App emerged in several essays but only one student expressed a wish for a user manual component (Fig. 1).

In relation to *utility of the App*, the students predominantly found the App enabled privacy (80.8%) and that it saved time in student-teacher cooperation (76.9%). In addition, the students appreciated having all practicum documents in one central and easily accessible place (71.2%) and felt that the teacher responded quickly enough (96.2%), was easy to approach (92.3%), easy to reach (90.4%) and was aware of each student's individual learning objectives (90.4%). The mean SUS score was statistically significantly higher for students who experienced their use of the App as a ubiquitous and time saving method for practicum procedures in addition to facilitating learning and individual teacher supervision (all  $p < .048$ ) (Table 6).

In the essays, most of the students stated cooperation with their teacher was quick and easy when using the App and found that their teacher's response time was quicker, cooperation was more fluent as messages were not lost in an e-mail system and teacher support was perceived as more available when using the App. Furthermore, most of

the students found the App allowed them freedom when taking care of the paper-based practicum documentation forms and this enabled the hands-on use of the documentation forms accessible via the App. Hence, the students felt the App was a positive innovation that enabled the unlimited documentation of their learning objectives and evaluation without the concerns of limited space for paper-based forms. Moreover, students perceived the App as supporting their self-reflection and consequently were encouraged to use their mobile devices for purposes other than the use of the App, for example, they were used for information retrieval to support clinical learning. Overall, the students found that it was easier to follow their own learning progress and to maintain their self-evaluation by using the personal documentation available via the App as a source of support. Furthermore, the App generated a central location for accessing practicum procedures that did not require a time and place frame and it was also reported to save time by automatically calculating the planned and actual practicum hours. However, some issues regarding practicum shifts and the storage of documentation were reported as problematic. As a result, some students found their use of App to be time-consuming and reported issues with running the software. In addition, the lack of a printing option for the documents was criticised (Fig. 1).

## 5. Discussion

The first aim of this study was to describe the development of the App for student-teacher cooperation. In order to confirm that the App meets the needs and expectations of the students, the usability of the App was tested in real clinical learning environments and examined as part of the process evaluation. In terms of usability, the App revealed good properties on most of the SUS items and generated a mean SUS score of 69.86, which indicates it has rather good usability but requires further development. In addition, the data gathered from the essays support the obtained mean SUS score as positive feedback and several positive features regarding the usability of the App but also recommendations for its development were reported. Students who took their internal medicine clinical practicum reported statistically

**Table 6**  
Utility of the App (N = 52) and SUS scores for utility variables.

Utility of the App Variables	SUS scores		SUS scores		p-Value
	Yes n (%)	No n (%)	Yes Mean (SD)	No Mean (SD)	
When using the App, I experience that					
it was a time saving method regarding practicum documentation	34 (65.4)	18 (34.6)	76.99 (15.60)	56.39 (20.49)	< .001*
it was a time saving method for cooperation with the teacher	40 (76.9)	12 (23.1)	73.94 (16.88)	56.25 (23.68)	.018*
it was a time saving method for cooperation with peers <sup>a</sup>	NA	NA	NA (NA)	NA (NA)	NA
it was possible to use independent of time	34 (65.4)	18 (34.6)	74.63 (16.62)	60.83 (22.77)	.025*
it was possible to use independent of place	32 (61.5)	20 (38.5)	73.83 (20.13)	63.50 (18.20)	.032*
it enabled privacy in cooperation between student and teacher	42 (80.8)	10 (19.2)	72.98 (17.73)	56.75 (23.92)	.042
it enabled privacy in the cooperation between students	2 (3.8)	50 (96.2)	77.50 (10.61)	69.55 (20.17)	.703
it enabled the monitoring of the attaining of the learning objectives	24 (46.2)	28 (53.8)	77.92 (15.19)	62.95 (21.05)	.006*
it enabled self-directed learning	20 (38.5)	32 (61.5)	79.00 (16.71)	64.14 (19.79)	.003*
all documents were available in one central, easily accessible place	37 (71.2)	15 (28.8)	75.34 (15.01)	56.33 (24.20)	.007*
When using the App, I experienced that the nurse teacher					
responded quickly enough to me	50 (96.2)	2 (3.8)	69.50 (20.19)	78.75 (5.30)	.600
could react to my acute supervision needs	26 (50.0)	26 (50.0)	71.25 (17.71)	68.46 (22.11)	.840
was easy to reach	47 (90.4)	5 (9.6)	71.49 (19.29)	54.50 (20.87)	.076
was easy to approach	48 (92.3)	4 (7.7)	70.21 (19.58)	65.63 (26.33)	.837
gave me real time supervision	30 (57.7)	22 (42.3)	74.42 (16.37)	63.64 (22.81)	.086
was aware of my individual learning objectives	47 (90.4)	5 (9.6)	72.77 (16.93)	42.50 (26.63)	.014*
gave individual supervision	31 (59.6)	21 (40.4)	74.52 (17.27)	62.98 (21.86)	.048*
promoted my learning	27 (51.9)	25 (48.1)	72.69 (17.32)	66.80 (22.29)	.374
reduced my sense of fear	9 (17.3)	43 (82.7)	71.94 (27.01)	69.42 (18.44)	.377
relieved my stress	8 (15.4)	44 (84.6)	80.00 (20.13)	68.01 (19.50)	.057

SD = standard deviation; NA = not available.

<sup>a</sup> Missing participants (n = 52).

\* Statistically significant  $p$ -value < .05 (two-tailed).

significantly higher mean SUS scores compared to those in the surgical clinical practicum. This finding may be due to their more active App usage in the earlier stage of their studies, which is when the need for more extensive nurse-teacher cooperation regarding support and reflection has been reported (Killam and Heerschap, 2013; Price et al., 2011). Another reason may be that the health problems of the patients in the internal medicine wards were more complicated and the needs of the student-teacher reflection were greater. The finding of this study reveal that the usability of the App is connected to several variables that have to be considered and which require further examination if the App is to be optimized for use in the MCI.

The second aim of this study was to examine the acceptability of the MCI by exploring student commitment to and experiences with the MCI. It was found that students were predominantly in favour of the MCI. In addition, even though only one App functionality training session was arranged before the MCI, the students seemed to be able to use the App deftly, evaluating themselves as active App users and perceiving the App as easy to use and easy to learn. Those findings confirm previous studies revealing the high acceptability of mobile device use in clinical practicums among students (Johansson et al., 2013; Strandell-Laine et al., 2015) although contradictory results have also been reported (Beauregard et al., 2017). Nevertheless, the high acceptability of the MCI revealed in this study is an important factor supporting the potential success of MCI use in the future. In terms of utility, the App was experienced as a ubiquitous and time saving method for facilitating student-teacher cooperation and enabling the feeling of having accessible teachers, which confirms previous study findings (Beauregard et al., 2017; Doyle et al., 2014; Strandell-Laine et al., 2015). Additionally, in the previous literature, weak wireless connections (Martyn et al., 2014) and negative staff attitude towards mobile technology (Beauregard et al., 2017; Raman, 2015) were reported as decreasing the utility of mobile technologies in clinical practicums but this was not reported in this study. However, intermittent problems, which may be connected to weak wireless connections, were reported in this study regarding App usage.

Based on the study findings, the App seems to meet the students' needs and expectations for an easy and ubiquitous hands-on alternative for student-teacher cooperation during the clinical practicum. Nevertheless, the App needs still further development and the designing of additional features for the two last phases of the MADLC (Vithani and Kumar, 2014), i.e. the *Deployment Phase (VII)* for general use and the *Maintenance Phase (VI)* to generate a continuous process based on user feedback. By adding those final phases to the study it may be possible to develop a robust, optimal and updated App that can be used in the MCI to facilitate student-teacher cooperation and to improve students' clinical learning outcomes.

### 5.1. Limitations

First, the usability testing conducted as part of the process evaluation was a retrospective field study. Thus, not all the usability aspects were able to be examined and there is a lack of performance data (Barnum, 2011, p.137). The efficiency of the App, i.e. how long it takes for the users to complete the task in the App (Barnum, 2011, p.35) and errors made when using the App were not possible to observe. These are important usability dimensions and need to be studied in the future. Students extensively reported their success and failure regarding App usage both in the questionnaires and essays, producing rich feedback and preference data (Barnum, 2011, p.137–138) for the next phases of the App's development. Positively, the internal consistency of the SUS measured with the Cronbach's alpha was 0.89. Negative aspects included the student essays not being anonymised, thus it is possible that students were reluctant to give negative feedback. Although students were given the possibility to return the essays anonymously, that did not guarantee the same level of anonymity. Another issue was that generalizability problems regarding the findings were detected as

students were recruited from a single nursing school. Nevertheless, the sample was found to be representative of the Finnish student nurse cohort. Another potential problem was that only 10 essays were received from a total of 52 students but data saturation was achieved with those 10 essays (Polit and Beck, 2013). The acceptability of the MCI among teachers and mentors, representing the intervention providers and App end-users was not examined in this study and needs to be studied in the future. Despite the limitations described, this study was conducted from the students' perspectives, representing the end-users of the App in real clinical learning environments while also using different data collection methods, which provided rich data on the actual context of use (Barnum, 2011, p.39). Hence, it produced rich data on both the usability of the App and the acceptability of the MCI in advancing the further development of the MCI.

## 6. Conclusions

The results of this process evaluation provide new and valuable evidence for the nursing education. The MCI was highly accepted by students and their commitment to the MCI was very strong, possible because the App demonstrated rather good usability. MCI demonstrated to facilitate the student-teacher cooperation and reveals great potential for the successful transfer of the MCI in the context of the clinical practicum, where novel alternatives for this cooperation are needed. This study provides valuable evidence for the software development team as they conduct the next phases of the App's development. Moreover, this study provides a solid base for future studies in the field of nursing education research on mobile application development and the process evaluation of a complex mobile cooperation intervention.

### Declaration of Competing Interest

No conflict of interest has been declared by the authors.

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