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MEDICATION COMPETENCE OF NURSING STUDENTS IN FINLAND

Virpi Sulosaari

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“Life isn't about waiting for the storm to pass...It's about learning to dance in the rain.”

Vivian Greene

Virpi Sulosaari

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ABSTRACT

Safe medication management requires solid medication competence from the registered nurse. The role of undergraduate nursing education is to provide possibility to develop this competence. However, international nursing studies have highlighted variety in the amount, content and implementation of medication education. Previous studies have also reported deficiencies in medication competence of nurses and nursing students. Evaluation of medication education, the medication competence of nursing students and associated factors is necessary for the development of education and medication competence. The aim of this study was i) to describe the medication education in undergraduate nursing programmes in Finland, ii) to evaluate the medication competence of nursing students and iii) to identify factors associated with their medication competence.

The study was carried out in three phases: in the first phase, the study subject of registered nurses' medication competence and previously identified factors associated with nursing students' medication competence was defined based on two literature integrative reviews. In the second phase, a national survey on medication education was carried out with managers of undergraduate nursing programmes (n=22) and nurse educators (n=136). In the third phase, medication competence of nursing students at the beginning (n=328) and end of their education (n=338) was evaluated and factors associated with medication competence were identified. Data were analysed mainly by statistical methods.

Based on the results, the amount of medication education varied between the polytechnic schools (universities of applied sciences). The content of medication education was quite comprehensive. More attention needs to be put on the theoretical principles, self-treatment medication care and patient education. The medication competence of nursing students was evaluated regularly in all of the nursing programmes.

Nursing students' medication competence was evaluated with a knowledge test, medication calculation tasks and having them solve short patient vignettes. Factors potentially associated with students' medication competence were examined from three perspectives: 1) individual factors, 2) factors associated with clinical learning environment and 3) factors associated with educational institution. In the knowledge test the students achieved on average 72% correct answers, in medication calculation tasks 74%, and in patient vignettes 57% correct answers in deciding the best possible solution. Based on the results, the explanatory value of individual factors on students' medication competence was most evident. There was a difference between the students at the beginning and end of education. At the beginning students' previous academic success had a stronger association with medication competence, while at the end of the education students' abilities in self-regulated learning and study motivation were more significant factors.

As a conclusion, it seems that the results of this study are similar to findings from previous studies. The amount of medication education varies in curriculum level. However, estimating the actual amount of education is difficult due to the integrated content of education. Medication competence was slightly better than in previous studies, but deficiencies still exist. The development of medication education and competence calls for national and international research and development collaboration. The results of this study support this development and research.

Keywords: Medication competence, Nursing student, Nursing education, Clinical competence

Virpi Sulosaari

SAIRAANHOITAJAOPISKELIJOIDEN LÄÄKEHOIDON OSAAMINEN

Turun yliopisto, Lääketieteellinen tiedekunta, Hoitotieteen laitos, Suomi

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TIIVISTELMÄ

Lääkehoidon turvallinen toteuttaminen edellyttää sairaanhoitajalta hyvää lääkehoidon osaamisperustaa. Sairaanhoitajakoulutuksen tehtävänä on mahdollistaa tämän osaamisen kehittyminen. Kansainvälisissä tutkimuksissa on kuitenkin osoitettu, että lääkehoidon opetuksen laajuudessa, sisällössä ja toteutuksessa on vaihtelevuutta. Aikaisemmissa tutkimuksissa on raportoitu myös puutteita lääkehoidon osaamisessa sekä sairaanhoitajilla että sairaanhoitajaopiskelijoilla. Koulutuksen ja lääkehoidon osaamisen kehittämiseksi lääkehoidon opetuksen ja sairaanhoitajaopiskelijoiden lääkehoidon osaamisen monipuolinen arviointi ja osaamista selittävien tekijöiden tarkastelu on tarpeen. Tämän tutkimuksen tarkoituksena oli i) arvioida lääkehoidon opetusta suomalaisessa sairaanhoitajakoulutuksessa, ii) arvioida sairaanhoitajaopiskelijoiden lääkehoidon osaamista sekä iii) tunnistaa sairaanhoitajaopiskelijan lääkehoidon osaamiseen yhteydessä olevat tekijät.

Tutkimus toteutettiin kolmessa vaiheessa. Ensimmäisessä vaiheessa kahden integroidun kirjallisuuskatsauksen kautta määriteltiin tutkimuksen kohteena oleva sairaanhoitajan lääkehoidon osaaminen ja aiemmin tunnistetut sairaanhoitajaopiskelijan lääkehoidon osaamiseen yhteydessä olevat tekijät. Toisessa vaiheessa toteutettiin valtakunnallinen lääkehoidon opetukseen liittyvä kysely hoitotyön koulutusohjelmasta vastaaville koulutuspäälliköille (n=22) ja opettajille (n=136). Tutkimuksen kolmannessa vaiheessa opintojensa alku- (n=328) ja loppuvaiheessa olevien sairaanhoitajaopiskelijoiden (n=338) lääkehoidon osaaminen arvioitiin ja osaamiseen yhteydessä olevat tekijät tunnistettiin. Aineistojen analyysissä käytettiin pääosin tilastollisia menetelmiä.

Tulosten perusteella lääkehoidon opetuksen laajuus vaihteli eri ammattikorkeakouluissa, mutta opetuksen sisältö oli kuitenkin monipuolista. Lisää huomiota tulisi kiinnittää lääkehoidon teoreettiseen perustaan ja itsehoitoon sekä lääkehoidon ohjaukseen liittyviin sisältöalueisiin. Opiskelijoiden lääkehoidon osaamista arvioitiin säännöllisesti kaikissa ammattikorkeakouluissa.

Sairaanhoitajaopiskelijan lääkehoidon osaamista arvioitiin tutkimuksessa tietotestillä, lääkelaskentatehtävillä ja lyhyiden potilastapausten ratkaisemisen avulla. Lääkehoidon osaamiseen yhteydessä olevia tekijöitä tarkasteltiin kolmesta näkökulmasta: 1) yksilölliset tekijät, 2) kliiniseen oppimisympäristöön ja 3) ammattikorkeakouluun liittyvät tekijät. Lääkehoidon teoreettista osaamista arvioivassa tietotestissä opiskelijat vastasivat keskimäärin 72 prosenttiin kysymyksistä täysin oikein; lääkelaskuista täysin oikein oli 74 % ja potilastapauksissa 57 % valitsi parhaan mahdollisen toimintatavan. Tulosten perusteella sairaanhoitajaopiskelijan osaamista selittivät eniten yksilölliset tekijät. Lääkehoidon osaamiseen yhteydessä olevien tekijöiden välillä oli eroa opintojen alussa ja lopussa. Opintojen alkuvaiheessa opiskelijan aikaisempi opintomenestys oli yhteydessä lääkehoidon osaamiseen, kun taas opintojen loppuvaiheessa siihen olivat yhteydessä opiskelijan kyky itseohjautuvaan oppimiseen sekä opiskelumotivaatio.

Johtopäätöksenä voidaan todeta tutkimuksen tulosten olevan samansuuntaisia kuin aikaisemmissa tutkimuksissa. Lääkehoidon opetuksen laajuus vaihtelee opetussuunnitelmatasolla, mutta täsmällinen arviointi on vaikeaa opetuksen sisältöjen integroimisen takia. Sairaanhoitajaopiskelijoiden lääkehoidon osaaminen oli hieman parempaa kuin aikaisemmissa tutkimuksissa, mutta osaamisessa on edelleen puutteita. Lääkehoidon opetuksen ja osaamisen kehittäminen edellyttää kansallista ja kansainvälistä tutkimus- ja kehittämisyhteistyötä. Tutkimuksen tulokset tukevat lääkehoidon opetuksen sekä osaamisen tutkimusta ja kehittämistä.

Asiasanat: Lääkehoidon osaaminen, Sairaanhoitajaopiskelija, Hoitotyön koulutus, Kliininen osaaminen

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LIST OF ABBREVIATIONS

ANOVA	One-way analysis of variance
CINAHL	Cumulative Index for Nursing and Allied Health
ECTS	European Credit Transfer and Accumulation System
ERIC	Education Resources Information Centre
ILS	Inventory of Learning Styles
MCAF	Medication Competence and Associated Factors instrument
MCS	Medication Calculation Skill instrument (Grandell-Niemi 2005)
MECI	Medication Education Curriculum and Implementation instrument
MEDIC	Finnish Medicine and Health Sciences Database
MEI	Medication Education Implementation instrument
MEDLINE	National Library of Medicine
MNS	Medication Skills of Nurses instrument (Veräjänkorva 2003)
PUBMED	National Centre for Biotechnology Information
RN	Registered nurse
RR	Response rate
SD	Standard deviation
UAS	University of Applied Sciences (previously polytechnic school)
TENK	Finnish Advisory Board on Research Integrity

ORIGINAL PAPERS

This thesis is based on the following publications, which are referred to in the text with the Roman numbers I-IV.

I Sulosaari V, Suhonen R & Leino-Kilpi H. 2011. An integrative review of the literature on registered nurses' medication competence. *Journal of Clinical Nursing* 20(3-4), 464-478.

II Sulosaari V, Kajander S, Hupli M, Huupponen R & Leino-Kilpi H. 2012. Nurse students' medication competence - an integrative review of the related factors. *Nurse Education Today* 32(4), 399-405.

III Sulosaari V, Huupponen R, Torniainen K, Hupli M, Puukka P & Leino-Kilpi H. 2013. Medication education in nursing programmes in Finland– findings from a national survey. *Collegian: The Australian Journal of Nursing Practice, Scholarship and Research* 21(4), 327-335.

IV Sulosaari V, Huupponen R, Hupli M, Puukka P, Torniainen K & Leino-Kilpi H. 2015. Medication competence of nursing Students and associated factors at the beginning and end of their studies. *BMC Medical Education* 15(1), 223. DOI: 10.1186/s12909-015-0513-0

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The summary also includes previously unpublished material.

1 INTRODUCTION

Registered nurses (RN) comprise the largest workforce of health care professionals involved in medication management (Eisenhauer et al. 2007, Lim & Honey 2014). Medication management as a professional task is a routine, yet complex and high-risk activity (Covell & Ritchie 2009, Hewitt et al. 2015, Sneck et al. 2016) forming a major part of nurses' responsibilities in their everyday practice (Armitage & Knapman 2003, Keohane et al. 2008, Elganzouri et al. 2009, Covell & Ritchie 2009, Dilles et al. 2010, 2011, Lim & Honey 2014). Adherence to medication care has been identified as a challenge, and as part of an interdisciplinary team RNs are responsible for patient education and supporting patients' adherence to medication (Latter et al. 2001, Finnish Medicines Agency [Fimea] 2012). Therefore nurses have an essential role in the rational and judicious use of medicines as well as in minimizing the adverse events that can potentially occur (Dilles et al. 2010, Hemingway et al. 2011, Johansson-Pajala et al. 2015). Due to the high rate of medical errors (Balas et al. 2004, Leufer & Clearly-Holdforth 2013), of which medication errors are the most common type (Barker et al. 2002, World Health Organization [WHO] 2004, 2012, Hughes & Ortiz 2005, Tang et al. 2007, Sheu et al. 2009, Cousins et al. 2012, Ruuhilehto et al. 2011, Keers et al. 2013a, Adhikari et al. 2014), patient and medication safety is a global concern for health care and education in general (Leufer & Cleary-Holdforth 2013). Nurses' role in medication safety has been highlighted as the final safeguard against medication errors (Leufer & Clearly-Holdforth 2013). Promoting medication safety is therefore a concern for the nursing profession and nursing education both nationally (Suikkanen 2008, Ruuhilehto et al. 2011) and internationally (Choo et al. 2010, Cooper 2014, Hewitt et al. 2015, Sneck et al. 2016).

Medication errors can occur in any phase of the medication administration process and may result from interaction of many factors (Harding & Petrick 2008, Keers et al. 2013a, 2013b, Härkänen et al. 2013). Many organizational and individual factors contribute to medication errors, such as workload, patient profiles and nurse's experience of stress (O'Shea 1999, Armitage & Knapman 2003, Fry & Dacey 2007, Milligan 2007, Page & McKinney 2007, Tang et al. 2007, Keers et al. 2013b, Härkänen et al. 2013, Pitkänen et al. 2014, Parry et al. 2015). Deficiencies in nurses' (Armitage & Knapman 2003, Tang et al. 2007, Choo et al. 2010, Lu et al. 2013, Pitkänen et al. 2014) and nursing students' medication competence (Konkloski et al. 2001, Wolf et al. 2006, Harding & Petrick 2008, Wolf et al. 2009, Keers et al 2013b, Schneidereith 2014) are among the factors contributing to medication errors. Thus the professional competence of nursing students upon graduation is at the core of the quality and safety of patient care (Kajander-Unkuri et al. 2014). Medication competence is one of the essential professional competence areas of novice nurses (Gerrish 2000, Boxer & Kluge 2000, Simonsen et al. 2014). Nursing teachers are therefore challenged to provide the didactic content and clinical experience for students that will ensure the development of medication competence necessary for safe

medication management (Cooper 2014) and to ensure that students understand the complexity of medication safety and understand their role as nurses (Bourbonnais & Caswell 2014).

Undergraduate medication education has undergone considerable scrutiny over the last decades in terms of the content and amount of the education (Morrison-Griffiths et al. 2002, King 2004, Lim & Honey 2006, Manias 2009, Dilles et al. 2011, Lu et al. 2013, Fleming et al. 2014) since several studies have highlighted concerns over nurses' (Ives et al. 1996, Ndosi & Newell 2009, Hsaio et al. 2010, Simonsen et al. 2011, 2014, Fleming et al. 2014) and nursing students' medication competence (Grandell-Niemi et al. 2005, Grandell-Niemi et al. 2006, Rainboth & DeMasi 2006, McMullan et al. 2010, Dilles et al. 2011, Simonsen et al. 2014, Amster et al. 2015). Previous studies indicate that graduating students are inadequately prepared and do not have the medication competence to fulfil their role in medication management (Latter et al. 2000, 2001, Manias & Bullock 2002a, 2002b, Morrison-Griffiths et al. 2002, Meechan et al. 2011, Simonsen et al. 2014). Therefore, attention needs to be put on evaluating nurses' undergraduate education (Deans 2005, Manias 2009, Dilles et al. 2011, Cooper 2014) and on gaining a more in-depth understanding of the medication competence of nursing students' and the factors associated with it.

The ultimate goal of this study is to evaluate and improve the quality of nursing education in one of the core nursing competence areas related to patient safety. This study aims to describe the current medication education in undergraduate nursing programmes in Finland, to evaluate the medication competence of nursing students, and to identify factors associated with their medication competence.

2 REVIEW OF THE LITERATURE

The literature review consists of three parts summarizing previous nursing literature in the field of medication education and medication competence of nurses and nursing students. First, the main concepts of the study are described. Second, previous research of medication education in undergraduate nursing education is described. Third, a description of RNs' medication competence as a competence goal for undergraduate nursing education is provided and results of previous research on nursing students' medication competence and associated factors are described. Finally, a summary of literature and the framework of the study is formed.

2.1 Main concepts of the study

The main concepts of this study are medication education and registered nurses' medication competence (Figure 2). In the research field of this nursing education research, several concepts with variations in content has been used, such as "pharmacology education", limited mainly to pharmacology and patient education as a topic (Latter et al. 2001), including only calculations, principles of medication administration and effects of medications (Zellner et al. 2003), including only pharmacology and some elements of medication management (Morrison-Griffiths et al. 2002, Dilles et al. 2011), "medicines management training and education" including pharmacology and medication management (Heminway et al. 2011), "medication administration education" limited to the process of giving medication to patients (Krautscheid et al. 2011) and "pharmacology and medicines management curriculum" (Meechan et al. 2011). In this study, the concept of "Medication education" is introduced to combine the different elements of these concepts.

The concepts used in describing nurses' medication competence also vary in previous studies. The concept of "pharmacological knowledge" was used by Ives et al. (1996) and Dilles et al. (2011). The concept "medication skills" was used by Veräjänkorva (2003) integrating areas of knowledge and skills. Grandell-Niemi (2005) used the concept "pharmacological skills" and Powell et al. (1998) and Jeffries (2001) used the concept of "medication administration skills". There is also great variety in the concepts used to describe students' abilities on medication calculation (examples): "Medication calculation skills" (Dilles et al. 2011) "numeracy skills" (McMullan et al. 2010), "medication calculation competence" (Young et al. 2013) and "drug calculation skills" (Wright 2006). In the study of Grandell-Niemi (2005) "medication calculation skills" included student's mathematical skills and pharmacological knowledge. In this study, the concept of "medication competence" is introduced to combine the different elements of these concepts (I).

MEDICATION EDUCATION

- A competency-based curriculum including theoretical and practical aspects of pharmacology, pharmacy, clinical pharmacology, medication management, clinical decision-making, patient medication education, adherence to medication care and promotion of medication safety.

MEDICATION COMPETENCE

- consists of theoretical, practical, and decision-making competence.
- is interrelated and linked to the nurse's values and attitudes.
- is associated with the nursing setting and the individual situation of the patient

Figure 1. Main concepts of the study

Both concepts, medication education and medication competence, are related to the medication management activities of nurses. Although medication management is not the main concept of this study, a description of the activity is needed for understanding the professional tasks of nurses for which undergraduate education prepares them and in which the medication competence becomes visible. The concept of "medication administration" has previously been used in describing the process of giving medication to patient (Krautscheid et al. 2011) or including also other elements of the medication administration process, such as planning and evaluating medication care (Coyne et al. 2013). Folkmann & Rankin (2010) has introduced the concept of "medication work" to include also non-observable elements of medication administration, while Dilles et al. (2010) have come up with the concept of "pharmacotherapeutic activities", defined similarly as "medication management" in this study. In this study the concept of "medication management" was chosen to describe nurses' activities in the overall medication administration process of medication care. Medication management consist of nurses' professional activities in delivering medication care, including a variety of tasks in all the phases of the medication administration process.

Registered nurses' education in Finland is bachelor-level education consisting of 180 ECTS + 30 ECTS (210 ECTS). The programme is a full-time course with seven semesters, one ECTS credit corresponding to 27 working hours on the part of the student (European commission 2016). The Finnish higher education system consists of two complementary sectors: universities of applied sciences and universities. Undergraduate nursing (RN) education is provided in the universities of applied sciences. (Finnish Ministry of Education and Culture http://www.minedu.fi/OPM/Koulutus/ammattikorkeakoulutus/?lang=en). Recently the English name of the polytechnic school was officially changed to University of Applied Sciences (UAS).

2.2 Literature search

The literature search process was conducted in three parts based on the purposes of the study. First, a review on previous literature on medication education in undergraduate nursing education was undertaken covering the years 1990-2009. Second, a systematic integrative review on registered nurses' medication competence was conducted covering the years 1998-2009 (I). Third, a systematic integrative review on factors associated with nursing students' medication competence was conducted covering years the 1990-2010 (II). Finally, the literature search processes were updated to cover the years 2010-2016 January (Table 1).

Table 1. Literature search and search terms

Focus	**Databases**	**Search terms**
Medication education	PUBMED (National Centre for Biotechnology Information), CINAHL (Cumulative Index for Nursing and Allied Health), MEDLINE (National Library for Medicine's), ERIC (Education Resources Information Centre) and MEDIC (Finnish Medicine and Health Sciences Database)	**"**pharmacology education" **OR** "medication education**" OR** "medication administration education" OR "medication management education" **AND** "education, nursing". limit: academic journals
Medication competence of registered nurses	PUBMED, CINAHL, MEDLINE, and MEDIC	"pharmacotherapy" **OR** " drug therapy" **OR** "medication" **OR** medication skills" **OR** "medication administration" **OR** "medication management" **AND** "nursing" A**ND** "skills" **OR** "knowledge" **OR** "competence" **OR** "nurses role" MEDIC Lääkeh*AND hoitotyön koulutus
Medication competence of nursing students and associated factors	PUBMED, CINAHL, MEDLINE, and MEDIC	"nursing student" " **AND** "medication competence" **OR** "pharmacology" **OR** "drug calculation" **OR** "numeracy" **OR** "medication calculation" **OR** "Medication administration" **OR** "Medication management" **NOT** "medication error" MEDIC Lääkeh***AND** hoitotyön koulutus limit: academic journals

2.3. Medication education

The goal of undergraduate medication education is to provide meaningful, relevant and effective teaching that prepares nursing students for entry into nursing practice (Latter et al. 2000, Krautscheid et al. 2011). The content of the education reflects the needs of nurses' everyday work and the challenges of an ageing society (Meechan et al. 2011). Once registered to practice nurses make informed decisions based on their knowledge that has developed during undergraduate education and apply that knowledge into nursing practice (Alcock et al. 1997, Eisenhauer et al. 2007, Hemingway et al. 2011). Given the large amount of time RNs spent on medication management and the complexity of the task (Elqanzouri et al. 2009), there has been increasing concern that undergraduate nursing curricula may not sufficiently be preparing students to undertake this responsibility (Meechan et al. 2011, Lim & Honey 2014). Comprehensive medication education (Table 2) involving understanding of the scientific principles underpinning medication care as well as conceptualizing medication management to the complex and changing needs of patients is essential to nursing practice (Jordan & Hughes 1998, Manias & Bullock 2002b, Meechan et al. 2011, Lu et al. 2013, Lim & Honey 2014). This science base is combined with nursing practice during clinical practice where nursing students learn more context-specific information and regulatory considerations related to medication management (Lim & Honey 2006).

Table 2. Summary of the core content on undergraduate medication education based on previous studies and Finnish national recommendations (Latter et al. 2001, Morrison-Griffiths et al. 2002, Manias & Bullock 2002a, 2002b, Veräjänkorva 2003, King 2004, Manias et al. 2004b, The Ministry of Social Affairs and Health [STM] 2005, Lim & Honey 2006, The Finnish Ministry of Education 2006, Elliot & Liu 2010, Meechan et al.2011, Lo et al. 2013, Vaismoradi et al. 2014, Ammattikorkeakoulujen Terveysalan verkosto ja Suomen sairaanhoitajaliitto 2015, THL 2016)

Main content	General content	Specific content
Regulatory guidelines Professional codes of conduct	Laws, regulations, protocols and therapeutic guidelines Guidelines of professional ethics	National regulation Hospital guidelines and protocols Nurses legal and professional accountability
Pharmacology and clinical pharmacology	Theoretical and practical aspects of pharmacodynamics pharmacokinetics toxicology pharmacy Medication care of specific age and patient groups (e.g. medication care of diabetes) and situations (e.g. anaphylaxis)	Drug development Drug formulations and routes Rational and therapeutic use of medicines Normal dose Therapeutic effect Side-effect, adverse effect Drug interactions Precautions Drug allergy Drugs with the elderly, pediatrics, pregnant/breastfeeding woman, renal patient, hepatic patient Substance abuse Drug misuse Inappropriate drug therapy Polypharmacy Prescription medicines Self-treatment medicines High Risk Medicines
Medication management	***Assessment prior to medication administration*** Planning of medication care (e.g. timing) Handling and preparation of medicines (incl. medication storage, dispensing, disposal) ***Medication administration*** ***Assessment on and after medication administration*** Monitoring and evaluation of the effectiveness of medication care ***Patient medication education and adherence to medication care***	Medication care as part of overall patient care Interpretation of patient data before and after medication administration Dosage and administration (incl. medication calculation) The use of technological equipment and electronic patient records Medication administration via different routes and by different medicine forms Documentation Monitoring and evaluation methods Evidence-based patient medication education and method to support patients' adherence to medication care
Patient and medication safety	Prevention of adverse events in medication care and promoting medication safety	Medication errors and nursing practice, adverse event screening and reporting

However, the undergraduate medication education has been criticized over the last decade in relation to the amount, content, relevance clinical practice possibilities (Latter et al. 2001, Bullock & Manias 2002, Manias & Bullock 2002a, Morrison-Griffiths et al. 2002, King 2004, Lim & Honey 2006, Page & McKinney 2007, Reid-Searl et al. 2009, 2010a, 2013, Manias 2009, Meechan et al. 2011, Fleming et al. 2014), assessment of nursing students' competence (Gonzales 2012) and not being adequate for the realities of nursing practice (Latter et al. 2000). Previous research indicates that the amount and content of education varies among educational institutions within universities in one country (Latter et al. 2001, Morrison-Griffiths et al. 2002, Manias 2009, Dilles et al. 2011), and there are inconsistencies and a lack of agreement regarding the emphasis on medication education in undergraduate nursing curriculum (Hemingway et al. 2011, Fleming et al. 2014). In the study of Morrison-Griffiths et al. (2002) the strongest emphasis was on practical skills of medication administration. Less emphasis was placed on theoretical and practical aspects of pharmacology and non-prescription (self-treatment) medication care. This lack of consistency across educational programmes regarding the provision of pharmacology education may hinder the acquisition of fundamental knowledge (Latter et al. 2001, Manias & Bullock 2002a, King 2004, Meechan et al. 2011).

Nurses (Manias & Bullock 2002b, King 2004), nursing students (Latter et al. 2001, Morrison-Griffiths et al. 2002, Manias & Bullock 2002a, Honey & Lim 2008, Hakkarainen 2011, Vaismoradi et al. 2014) and nurse teachers (Bullock & Manias 2002, Manias & Bullock 2002a) have expressed dissatisfaction with nurses' educational preparation on pharmacology and medication management. Concerns have been raised about the lack of pharmacology teaching (King 2004, Manias 2009), teacher's competence and abilities to teach medication education (Veräjänkorva & Leino-Kilpi 1998, Latter et al. 2001, Morrison-Griffiths et al. 2002, Simonsen et al. 2014) and integration of theory and practice (Manias & Bullock 2002a, Manias & Bullock 2002b, Zellner et al. 2003, Honey & Lim 2008, Aggar & Dawson 2014). Criticism on the use of traditional teaching methods in pharmacology education not supporting theory practice integration has also been raised (Morrison-Griffiths et al. 2002, Banning 2004). Bridging the gap between theory and practice is important in preparing students to safely administer medicines without compromising patient care (Sears et al. 2010, Aggar & Dawson 2014, Harris et al. 2014). Pharmacology as a learning subject has been seen as difficult by students and teachers (Latter et al. 2001, Manias & Bullock 2002b) and learning requires good abilities of self-directed learning on the part of students (Latter et al. 2001, Manias & Bullock 2002b, Meechan et al. 2011) as well as abilities to integrate theory into nursing practice on the part of teachers and nurse mentors (Latter et al. 2001, Morrison-Griffiths et al. 2002).

Concerns about over-reliance on the clinical practice placements with busy, over-stretched nurse mentors have also been raised (Hemingway et al. 2011). The opportunities for integration of knowledge and skills are necessary to ensure the development of competent decision-making skills (Lim & Honey 2006), and as students become exposed to patient care in the clinical setting medication education becomes integrated

into the clinical context (Honey & Lim 2008, Andrew & Mansour 2014). The role of nurse managers and nurse mentors as role models has also been found to be important for nursing students' learning on issues related to medication safety and how it reflects on nursing practice (Murphy 2012, Andrew & Mansour 2014). However, according to previous studies, there seems to be a lack of supervision, support by the nurse mentors (Reid-Searl et al. 2009, Reid-Searl et al. 2010a, Orbæk et al. 2015) and possibilities to practice (Vaismoradi et al. 2014). If nursing students are to become competent, their learning requires extensive support and collaboration from both academic institutions and clinical mentors (Manias & Bullock 2002a, Manias & Bullock 2002b, Vaismoradi et al. 2014).

To answer these challenges raised by researchers, there has been an evident increase in nursing education research aimed at finding the most effective methods to teach and learn. The use of a variety of teaching and learning methods seems to be the most effective method (e.g. Hunter Revell & McCurry 2013, Ramjan et al. 2014, Stolic 2014, Vana & Silva 2014), in addition to development of simulated learning environments (e.g. Sears et al. 2010, Harris et al. 2014, Amster et al. 2015) and clinical skill workshops (e.g. Grugnetti et al. 2014). When analysing the results of studies evaluating the effectiveness of teaching methods, it is necessary to recognize the critique levelled at nursing education research. Current nursing education research has been criticized for not being scientifically rigorous; conclusions are based on small size single studies and outcome measures of competence are often poorly defined and narrow (Foundation for Nursing Education [NLN] 2009, Valiga & Ironside 2012). Based on the literature reviews in this study, this critique is well justified. It is difficult to compare previous research findings due to lack of coherence in competence definitions and in learning outcomes, instrumentation, reporting and overall research designs. Thus, the focus of this study is not to explore the effectiveness of teaching and learning strategies and methods. In this study, a general overview will be provided of the content and amount of medication education in undergraduate nursing programmes in the universities of applied sciences (hereafter schools), together with information on factors associated with medication competence of nursing students (III, IV).

2.4 Medication competence

In this chapter, first a description of the study subject, registered nurses' medication competence, is provided (I). Second, a summary of previous research on nursing students' medication competence is described. Third, an updated review of previously identified factors associated with nursing students' medication competence is provided (II). Fourth, a summary of the literature review and framework of the study is shown.

2.4.1 Description of registered (RN) nurses' medication competence

Registered nurses have an essential role in patients' medication administration process (Keohane et al. 2008, Elganzouri et al. 2009, Pirinen et al. 2015, Sneck 2016) and are accountable for their actions in delivering medication care to their patients (King 2004, Choo et al. 2010). Nurses' understanding of the theoretical and clinical aspects of pharmacology influences their practice (Manias & Bullock 2002b, King 2004, Choo et al. 2010) in correlation with their clinical experience (Ndosi & Newell 2009). To be able to make decisions on patients' medication care, nurses must have an understanding of the theoretical and practical aspects of medication management and regulatory and ethical guidelines of the profession (Murtola 1999, Veräjänkorva 2003, Manias et al. 2004a, 2004b, Aitken et al. 2006). The decision-making competence also requires critical thinking skills, skills to assess the patient's condition and the ability to respond to changing situations (e.g. Aitken et al. 2006, Eisenhauer et al. 2007).

The medication administration process is based on multidisciplinary collaboration and requires practical competence on planning, implementing and evaluating medication care (Manias et al. 2004a, 2004b, Aitken et al. 2006, Lim & Honey 2014, Pirinen et al. 2015). It requires cognitive knowledge, especially related to thinking in the moment about the appropriateness of the medication, dosage, timing, selecting the right medication, assessment, interpretation of assessment data, anticipating risks, patient medication education, documentation and planning of evaluation of medication effectiveness. Each of these clinical judgment actions requires vigilance and critical thinking (Alcock et al. 1997, Eisenhauer et al. 2007) and is related to good communication skills (Manias et al. 2005), information-seeking skills (Grandell-Niemi et al. 2005), abilities to work in a multidisciplinary team (Manias et al. 2005) and skills to promote medication safety (Veräjänkorva 2003, McMullan et al. 2010). To be competent, nurses must be able to integrate theoretical, practical and decision-making competence into their clinical practice (Leufer & Cleary-Holdforth 2011, Lim & Honey 2014).

In this study, an integrative literature review was conducted to describe the general medication competence of registered nurses without expertise in a specific nursing setting or extended professional duties (I). The level of registered nurses' and nursing students' medication competence is not compared in this study. However, as one of the study results, the results of the review (Figure1) describe medication competence as an outcome of education and were therefore the basis for the evaluation methods used in this study.

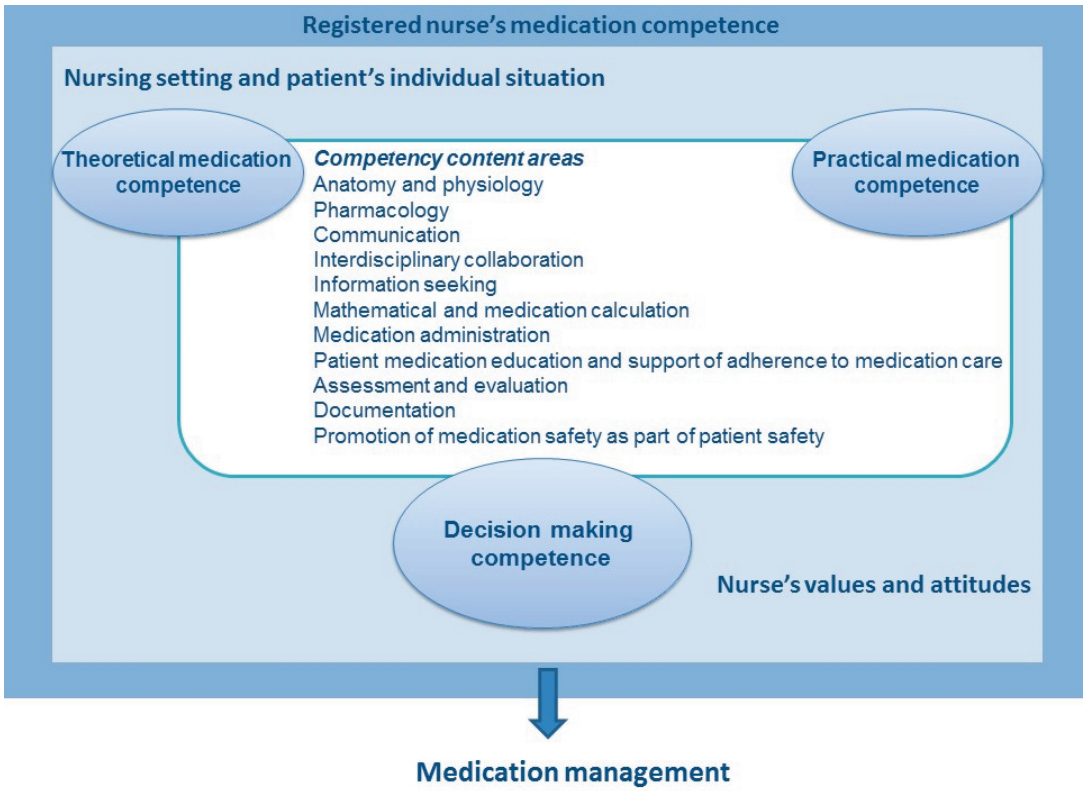

Figure 2. Registered nurse's medication competence and competency content areas

2.4.2 Medication competence of nursing students and associated factors

Medication competence of nursing students

In order to practise safely, nursing students need to develop adequate medication competence integrating theoretical and practical medication competence and learn to apply it to decision-making in the context of clinical processes (Amster et al. 2015). Medication competence of nursing students is related to the quality and safety of care. Concerns have been raised of nursing students' medication errors (Wolf et al. 2006, 2009, Harding & Petrick 2008, Dolansky et al. 2013, Cooper 2014) and lack of supervision when students administer medicines in clinical practice (Dolansky et al. 2013, Reid-Searl et al. 2010b, 2013). Student medication errors have resulted from omission, improper dose or quantity, wrong time, or administration of an extra dose (Wolf et al. 2006). Students themselves have expressed that their education programmes leave them vulnerable to drug errors (Vaismoradi et al. 2014). Traditionally, to avoid medication errors, nursing students are taught to use the simple Five Rights method when administering medicines: Right patient, Right medication, Right dose, Right time and Right route (Harding & Petrick 2008, Kohtz & Gowda 2010, Reid-Searl et al. 2010b, Bourbonais & Cawell 2014).

The Rights method has been designed to keep medication care safe for the patients (Elliot & Liu 2010). Over time, additional rights have been proposed to the list, such as Right documentation, Right action or Reason medication ordered, Right medicine form and Right response from the patient (Elliot & Liu 2010). Previous studies suggest that when the five rights are not verified a medication error can occur (Konkloski et al. 2001, Harding & Petrick 2008, Pauly-O'Neill 2009, Jones & Treiber 2010, Sears et al. 2010). In the retrospective analysis of Harding & Petrick (2008) on nursing student medication errors the contributing factors were rights violations, system factors and students' knowledge and understanding indicating deficiencies in students' medication competence and non-adherence to the Rights method. Recently, Schneidereith (2014) found nursing students becoming more neglectful in verification of the five rights as they progressed through the curriculum. However, the study by Amster et al. (2015) indicated nursing students' medication administration errors to be more related to deficiencies in students' pharmacological knowledge than to their rule-based knowledge when using an Eye Tracking device to observe students' performance in simulated situations.

Several studies have highlighted deficiencies and a need for development in nursing students' medication competence (Table 3). However, the main focus in previous studies evaluating students' medication competence has been on evaluation of students' practical medication competence in numeracy and medication calculations (Flynn & Moore 1990, Blais & Bath 1992, Kapborg 1994, 1995, Gilham & Chu 1995, Hutton 1998, Cinar et al. 2006, Grandell-Niemi et al. 2001, 2006, Kapborg & Rosander 2001, Brown 2006, Harne-Britner et al. 2006, Jukes & Gilchrist 2006, Wright 2006, McMullan et al. 2010, Dilles et al. 2011,

Eastwood et al. 2011, Arkell & Rutter 2012, Coyne et al. 2013, Ramjan et al. 2014) and major concerns over medication calculation abilities of students have been raised (Blais & Bath 1992, Kapborg 1995, Gilham & Chu 1995, Grandell-Niemi et al. 2001, 2006, Jukes & Gilchrist 2006, McMullan et al. 2010, Dilles et al. 2011). The practical medication competence in administering medications has been evaluated by Powell (1998), Jeffries (2001) and Holland et al. (2013), with students performing quite well in the practical competence test. However, medication competence evaluation was not the focus in these studies.

Evaluation of the theoretical medication competence of students has only been reported in a few studies indicating deficiencies in the pharmacological knowledge base of nursing students (Grandell-Niemi et al. 2005, Dilles et al. 2011, Simonsen et al. 2014). In the study of Grandell-Niemi et al. (2005), half of the students (n=282) achieved a score of 67%, and in the study of Dilles et al. (2011), 55% gave correct answers in the pharmacology knowledge test. Recently, Simonsen et al. (2014) found only an average score of 43% correct answers in evaluation of nursing students' knowledge of drug management. However, in the studies of Powell et al. (1998) and Jeffries (2001) the students achieved high scores in the knowledge test on oral medication administration. No studies evaluating decision-making competence of nursing students in relation to medication management were found in the literature review.

The main methodologies in evaluation of medication competence have been mathematical and medication calculation tests and knowledge tests on pharmacology. Recently, objective structured clinical examinations [OSCE] (Lauder et al. 2008, Hutton et al. 2010, Holland et al. 2013), online dosage assessment (Hutton et al. 2010) and Eye Tracking devices (Amster et al. 2015) have been used to evaluate the medication competence of students. The sample sizes of previous studies vary from one student group to larger samples. In studies evaluating teaching methods, small samples sizes seem to be most common. There is also variation in the reporting of the studies, making interpretation and creation of synthesis difficult.

Table 3. Summary of previous studies on medication competence of nursing students

Medication competence area	Author, year, country	Purpose of the study	Sample/test	Main findings
Numeracy skills	Kapborg 1995, Sweden	To investigate mathematical knowledge and skills in beginner nursing students in relation to varying educational backgrounds	1st year nursing students (n=975), numeracy test (65 calculations), calculators not allowed	The average score was 50% correct.
	Brown 2006, USA	Not reported	1st semester nursing students in year 1988 (n=234) and in year 2003 (n=294), numeracy test, calculators not allowed	The average scores were 76% correct in 1988 and 77% correct in 2003.
	Hutton 1998, UK	To explore the relationship between entry characteristics in mathematics and competence in nursing calculations	1st year nursing students (n=99), numeracy test (50 calculations), calculators not allowed	The average score was 51% correct.
	Wright 2006, UK	To examine the drug calculation skills of nursing students	2nd semester nursing students (n=71), numeracy test (30 calculations), calculators not allowed	The average score was 55% correct.
	Lauder et al. 2008, UK	To measure competence, self-reported competence and self-efficacy of nursing students	Nursing and midwife students (n=99), numeracy test OSCE (24 calculations)	The average score was 53% correct.
	Eastwood et al. 2011, Australia	To determine if undergraduate 2nd year nursing students could accurately calculate drug dosages and perform some basic mathematical calculations	2nd year nursing students (n=52), numeracy test (12 calculations), calculators not allowed	The average score was 56% correct.
	Arkell & Rutter 2012, UK	To assess numeracy skills of nursing, midwifery and pharmacy undergraduate students on entry to their respective programmes	Entry-level nursing (n=176), midwife (n=32) and pharmacy (n=70) students, numeracy test (14 calculations), calculators not allowed	The average score was 30% correct.

Medication competence area	Author, year, country	Purpose of the study	Sample/test	Main findings
Medication calculation skills	Blais & Bath 1992, USA	To analyse the dosage calculation errors of nursing students	1st year nursing students (n=66), medication calculation test, calculators not allowed	The average score was 53% correct answers.
	Kapborg 1994, Sweden	To investigate the knowledge and skills of nursing students in drug dosage calculation	Nurses (n=545), nursing students (n=197), medication calculation test (14 calculations), calculators not allowed	The average score was 67 % correct answers.
	Gilham & Chu 1995, USA	To analyse nursing students medication calculation errors	2nd year nursing students (n= 158), medication calculation test (20 calculations),unclear whether calculators were allowed	55 % of the students scored 100 % correct, average score not reported.
	Harne-Britner et al. 2006, USA	To assess the medication calculation skills of nursing students	Senior nursing students (n=31), medication iv calculation test (20 calculations), calculators allowed	The average pre-test score was 79 % and post-test score 87 %.
	Jukes & Gilchrist 2006, UK	To discover the drug calculation abilities of a group of undergraduate nursing students	2nd year nursing students (n= 37), medication calculation test (10 calculations), calculators allowed	The average score was 60 % correct.
	Kohtz & Gowda 2010, USA	To compare the use of 2 approaches to drug calculations dimension analysis and conventional methods (medication calculation competence evaluation as part of the overall study)	2nd year nursing students (experimental group n=36, control group n=43), medication calculation test (24 calculations), calculators allowed	In the experimental group 61 % of the students achieved 90 % accuracy score and in control group 65 %. The average score not reported.
	Coyne et al. 2013, Australia	To evaluate effectiveness of teaching method (medication calculation competence evaluation as part of the overall study)	2nd year nursing students (n=156), medication calculation test (10 calculations), calculators allowed	The average pre-test score was 70% and the average post-test score 95% correct.
	Grugnetti et al. 2014, Italy	To evaluate the effectiveness of a Clinical Skills workshop on students drug-dosage calculation skills	1st semester students (n=77), medication calculation test (30 calculations), calculators not allowed	The average pre-test score was 53 % and the average post-test 84% correct.
	Ramjan et al. 2014, Australia	To identify strategies for developing numeracy skills (numeracy skill evaluation as part of the overall study)	Final-semester nursing students (n=405), contextualized paper and pen test with graphics e.g. labels and syringes, unclear whether calculators were allowed	The average score was 70% correct in the initial test.
	Basak & Yildiz 2014, Turkey	To compare the effectiveness of cooperative teaching and learning methods on the development of drug calculation skills	Final year nursing students (n=85), control group n=40, intervention group n=32. Medication calculation test (20 calculations, calculators not allowed	The average score before training was 69% in the control group and 66% in intervention group. After training average score was 92 % in the control group and 87% in the intervention group.

Medication competence area	Author, year, country	Purpose of the study	Sample/test	Main findings
Numeracy and medication calculation skills	Grandell-Niemi et al. 2001, Finland	To describe the basic mathematical proficiency and the medication calculation skills of graduating nursing students in Finland	Graduating nursing students (n=180), numeracy and medication calculation test (17 calculations), calculators not allowed	Only one student achieved 100 % correct, average score not reported.
	Grandell-Niemi et al. 2006, Finland	To investigate self-rated and actual mathematical skills of graduating nursing students	Nursing students (n=283), numeracy and medication calculation test (29 calculations), calculators not allowed	The average score was 61 % correct.
	McMullan et al. 2010, UK	To examine the relations of age, status, experience and drug calculation ability to numerical ability of nursing students	2nd year nursing students (n=229), numeracy and medication calculation test (15 and 20 calculations), calculators not allowed	55% of the students failed the numeracy test, average score was 57 % correct. In medication calculation test the average score was 35 % correct.
	Harris et al. 2014, USA	To examine simulation method to improve nursing students medication calculation abilities	1st year nursing students (= 158, control group n=79, intervention simulation group n=79). Numeracy and medication calculation test (10mathematical and 9 medication calculations, simple calculators allowed	The average score in the intervention group was 95%, and in the control group 90% correct.
Pharmacological knowledge and medication calculation skills	Dilles et al. 2011, Belgium	To evaluate graduating nursing students' pharmacological knowledge and calculation skills	Graduating nursing students, diploma programme (n=209) and bachelor programme (n= 404), pharmacological knowledge test (25 statements) and medication calculation test (5 calculations), calculators not allowed	The average score on the knowledge test was 52% correct for diploma nursing students and 55% correct for Bachelor's degree students. The average score on the calculation test was 53% correct for diploma students and 66% for bachelor's degree students.
Pharmacological knowledge	Grandell-Niemi et al. 2005, Finland	To investigate the pharmacological skills of graduating nursing students.	Graduating nursing students (n=282), pharmacology knowledge test (24 statements)	The average score was 68 % correct.
	Aronsson et al. 2015, Sweden	To explore health care students understanding of the core concepts in pharmacology	Final semester health care students (n=12) of which medical students (n=4), nursing students (n=4) and specialized nursing programme of primary health care students (n=4). Interview	The students were able to define the pharmacological concepts, but showed less ability to reflect on it in depth and in relation to the clinical context.

Medication competence area	Author, year, country	Purpose of the study	Sample/test	Main findings
Medication administration skills	Powell et al. 1998, USA	To evaluate effectiveness difference in self-directed versus faculty-driven methods of students' performance in medication administration performance test	Baccalaureate nursing students (Control group n= 50, Intervention group n=42). Competence evaluation in learning laboratory (skill performance test)	In both groups average score was 99% correct activities
	Jeffries 2001, USA	To compare effectiveness of interactive multimedia CD-ROM and traditional lecture teaching of oral medication administration (performance evaluation as part of the overall study)	Junior baccalaureate nursing students (n=44), knowledge test (40 items) and competence evaluation in learning laboratory (check-list)	Pre-knowledge test average score was 85% correct, post-test 96% correct. 90% passed the competence evaluation
	Holland et al. 2013, UK	To evaluate the use of online video clip in medication administration (performance evaluation as part of the overall study)	1st year nursing students (n=243 Control group, n=266 Intervention group). Medication administration OSCE	High Pass score was achieved by 16%, Medium Pass score 32% in the Control group, in the Intervention group 18% achieved a High Pass score and 33% a Medium Pass score.
	Sowan & Idhail 2014, Jordan	To describe the experience and achievement of nursing students on a virtual course of medication administration	1st year undergraduate students (n=102), medication administration performance test	The average score after the course on the performance test was 75% out of 100%.
Pharmacological knowledge, medication calculation, and drug management skills	Simonsen et al. 2014, Norway	To compare the medication knowledge, certainty and risk of error between graduating bachelor students in nursing and experienced registered nurses.	Final semester nursing students (n=243), knowledge test including pharmacology (14 questions), drug management test (14 questions) and drug dose calculation (14 calculations), the use of calculators not reported	The average score was 61.5% correct answers, in pharmacology test 71%, in drug management test 43% and in medication calculation test 71 % correct answers.

Factors associated with nursing students' medication competence

As part of the overall study, a systematic integrative literature review was conducted for the purpose of identifying factors associated with nursing students' medication competence (II). The factors associated with students' medication competence identified in the review were A) individual and B) environmental factors. Environmental factors were divided into two perspectives: factors related to the clinical learning environment and to educational institution. As was the case in evaluation of nursing students' medication competence, previous research has focused mainly on individual factors associated with nursing students' numeracy and medication calculation skills (Table 4).

From the individual factors students' age (Hutton 1998, Grandell-Niemi et al. 2006, McMullan et al. 2010), previous academic success (Flynn & Moore 1990, Hutton 1998, Grandell-Niemi et al. 2001, 2006, Shikimi 2004, Wright 2006, Strayer & Beitz 2010, Arkell & Rutter 2012, Basak & Yildiz 2014) and the phase of nursing education (Cinar et al. 2006) have been associated with students' medication competence. A relationship between students' previous degree in nursing and medication competence has previously been suggested, but not verified (Kapborg & Rosander 2001, Grandell-Niemi et al. 2005, 2006). A relationship between students' mathematical success and the results in a medication calculation test has previously been verified (Hutton, 1998, Grandell-Niemi et al.2001, 2006, Wright 2006, Arkell & Rutter 2012). However the relationship is more important at the beginning of nursing education and does not predict students' performance later on (Hutton 1998, Alteren & Nerdal 2015).

Previous studies have revealed that certain approaches to learning are associated with better academic performance (Baxter et al. 2013). Suggestions on the relationship between students' learning styles and the critical thinking required for decision-making have been presented but not verified (Andreou et al. 2014). Students' experience of lack of confidence has also been associated with medication competence. Students who are less confident and have more anxiety achieve lower scores in numeracy tests (Glaister 2005, Andrew et al. 2009, McMullan et al. 2012). Students who have a negative attitude towards mathematics and testing are also more likely to perform worse than students who have a higher level of confidence (Glaister 2007). Thus, students' previous experiences in mathematics can also be associated with their level of confidence and feeling of anxiety (Røykenes & Larsen 2010, 2014).

Of the environmental factors, the clinical learning environment has been perceived by students as important for the development of medication competence (Manias & Bullock 2002a), and clinical practice placements allow them to develop an understanding of the effects of medication in real-life situations (Coyne et al. 2013). However, according to students' experiences, there are too few learning opportunities for practice (Manias & Bullock 2002a, Honey & Lim 2008) and a lack of support and supervision by nurse mentors in clinical

practice placement (Reid-Searl et al. 2010a, Orbæk et al. 2015). The efficacy of the practice placements affects the possibilities of applying pharmacological knowledge and practice in decision-making in medication care (Honey & Lim 2008). Thus, the relationship between clinical practice placements and nursing students' medication competence warrants further research.

Nurses (Manias & Bullock 2002a, King 2004) and nursing students (Manias & Bullock 2002b) have expressed dissatisfaction with their pre-registration medication education. Nursing students who were more satisfied with the level of their medication calculation education achieved better results on a medication calculation test in a study by Grandell-Niemi et al. (2006). Variation in education among educational institutes has also been identified to be associated with students' results on a pharmacology test, warranting further research (Grandell-Niemi et al. 2005). One factor related to the educational institute under scrutiny among nurse educators is the use of calculators in medication calculation education and competence evaluation (Tarnow & Werst, 2000, Pentin & Smith 2006, McMullan et al. 2010). Although mathematical skills are required in order to be able to calculate correctly, conceptualisation and interpretation of medication calculation to be solved has been seen as essential (Wright 2004). The use of calculators has also been associated with conceptual errors (Shockley et al. 1989). Therefore the use of a calculator does not improve results in numeracy or medication calculation tests if the problems are conceptual, but calculators can assist in solving calculation problems and decrease arithmetic errors (Gilham & Chu 1995, Tarnow & Werst 2000, Eastwood et al. 2011, Meechan et al. 2011).

Table 4. Summary of previous studies on factors associated with medication competence of nursing students

Associated Factor	Positive association	Inverse association	No statistical difference	Association suggested, not tested
Individual factors				
Older age	Hutton 1998[1)], McMullan et al. 2010[1)]		Flynn & Moore 1990[1)], Kapborg & Rosander 2001[1)], Grandell-Niemi et al.2005[2)], 2006[1)]	
Academic success	Shockley et al. 1989[1)], Flynn-Moore 1990[1)], Hutton 1998[1)], Grandell-Niemi et al. 2001[1)], 2005[2)], 2006[1)], Shikimi 2004[2)], Wright 2006[1)], Andrew et al. 2009[1)], Strayer & Beitz 2010[2)], Arkell & Rutter 2012[1)], Basak & Yildiz 2014[1], Ramjan et al. 2014[1], Alteren & Nerdal 2015[1),]			
Phase of education	Cinar et al. 2006[1)]			
Previous diploma degree in nursing			Kapborg & Rosander 2001[1)], Grandell-Niemi et al. 2005	
Positive perception of mathematics	Grandell-Niemi et al. 2001[1)]			Cinar et al. 2006[1)], RØykenes & Larsen 2010[1)]
Positive perception of pharmacology	Grandell-Niemi et al. 2005[2)]			
Attitude towards mathematics	Flynn & Moore 1990[1)], Wright 2006[1)], Glaister 2007[1)]			
Anxiety related to mathematics		Flynn-Moore 1990[1)], Glaister 2005[1)], Wright 2006[1)], Andrews et al. 2009[1)]		
Good self-confidence / self-efficacy	Glaister 2005[1)], Harne-Britner et al. 2006[1)], Andrew et al. 2009[1),] McMullan et al. 2012[1)], Ramjan et al. 2014[1)]	Arkell & Rutter 2012[1)]		Honey & Lim 2008[2)], RØykenes & Larsen 2010[1)]
Readiness for safe medication care			Dilles et. 2011[1)2)]	
Satisfaction with current amount of medication calculation education	Grandell-Niemi et al. 2006[1)]			
Learning style	Mathematical learning strategy – Blais & Bath 1992[1)]			Ability to self-regulated learning – Manias & Bullock 2002a[2)], Wright 2004[1)]

Environmental factors				
Factors related with clinical learning environment				
Practice possibilities	Grandell-Niemi 2005[2)], Grandell-Niemi et al. 2006[1)]			Manias & Bullock 2002a[2)], Honey & Lim 2008[2)]
Lack of supervision and support by nurse mentor in clinical placement				Manias & Bullock 2002a[2)] Reid-Searl et al. 2009[2)], 2010a[2)], 2010b[2)], 2013[2)]
Educational institution				
Lack of theory and practice integration in education				Latter et al. 2001[2)] , Manias & Bullock 2002a [2)]
Polytechnic school (UAS)	Grandell-Niemi et al. 2005[2)]			
Use of calculator (in medication calculation test)	Kapborg & Rosander 2001[1)]	Shockley et al. 1989[1)], Tarnow & Werst 2000[1)]		

[1)] numeracy/medication calculation, [2)] pharmacology/medication management

2.5 Summary of the literature review

First, summary of literature review is provided. Second, the framework of the study is described in Figure 3.

1) Medication education in undergraduate nursing programmes has been an interest of nurse educators for decades. However, previous studies on the content and implementation of medication education seem to be limited to a few countries. The content and amount of medication education has been indicated to vary among universities in Australia, UK and Belgium. Similar studies from Finland were not found in the literature review. Therefore, there is a need for the evaluation of medication education in undergraduate programmes in Finland.

2) Medication education forms a foundation on which students can build adequate medication competence during their studies. However, deficiencies exist in nursing students' medication competence. The main body of previous studies on nursing students' medication competence has emphasized students' medication calculation and numeracy skills, although calculation error is only one factor contributing to medication errors.

3) There is lack of research on evaluating students' theoretical medication competence and their ability to apply the knowledge into practice and make decisions on solving problems with patients' medicine regimens. As medication competence is more than just a technical and numeracy skill, research on medication competence from a broader perspective is warranted. Based on the literature review, research aimed at gaining stronger evidence on the effects of associated factors is also needed. In Figure 3 the overall framework of this study is described.

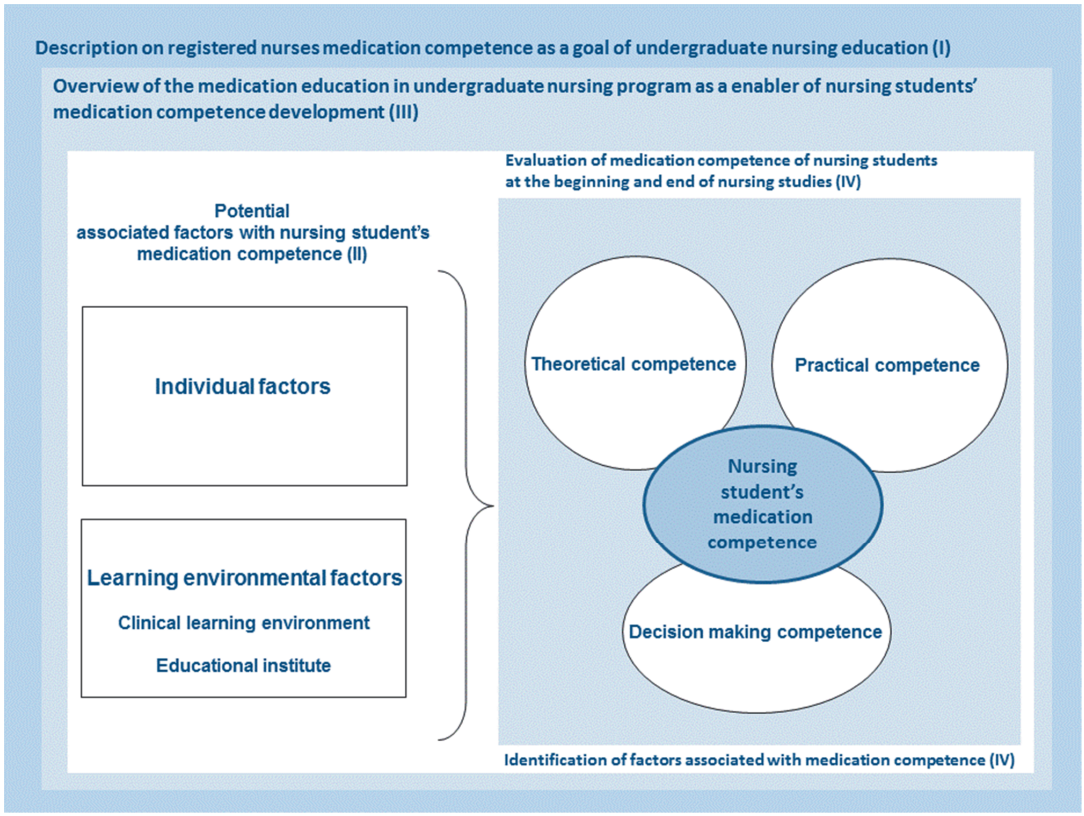

Figure 3. Framework of the study

3 PURPOSE OF THE STUDY AND RESEARCH QUESTIONS

The ultimate goal of this study is to evaluate and improve the quality of nursing education in one of the core nursing competence areas related to patient safety. This study aims to describe current medication education in undergraduate nursing programmes in Finland, evaluate the medication competence of nursing students, and identify factors associated with their medication competence (Figure 4).

More specifically, the following research questions were addressed:

Descriptive phase 1 (literature reviews I, II)

1. What is the medication competence of registered nurses? (I)

2. What factors have been associated with the medication competence of nursing students'? (II)

Evaluation phases 2-3 (empirical papers III, IV)

3. What is medication education in undergraduate nursing programmes in Finland? (III)

4. What is medication competence of nursing students and factors associated with it? (IV)

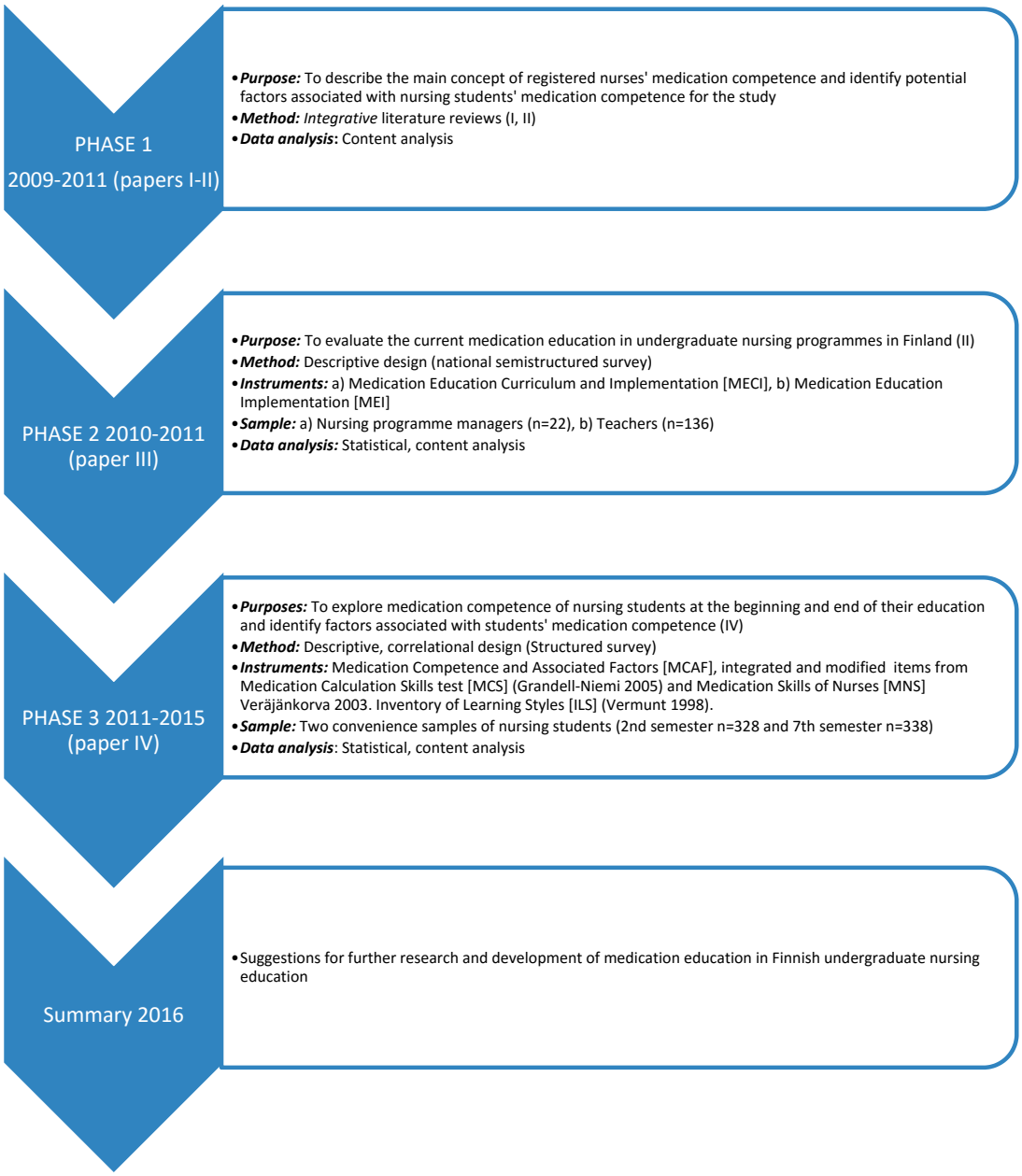

Figure 4. Study phases

4 MATERIALS AND METHODS

There are three phases in this study. In the first phase, two systematic integrative literature reviews were conducted (I, II). The results of the updated reviews are presented in the literature review chapter of this study summary. In the second phase, data were collected from managers of nursing programmes and teachers (III). In the third phase, data was collected from 2nd and 7th semester nursing students (IV). The following report on materials and methods is provided based on study phases two and three. In this chapter, the study samples, data collection and analysis methods are described (Table 5) and ethical considerations are discussed.

Table 5. Summary of the samples, data collection and analysis methods

Phase	Research question	Paper	Design	Instrument	Sample	Method of data collection	Data analysis
1	1,2	I, II	Descriptive (Integrative literature review)	-	Paper I: 21 empirical research papers Paper II: 12 research papers	Systematic literature search of research and evidence-based databases	Content analysis
2	3	III	Descriptive and explorative	Semistructured instruments MECI MEI	Nursing programme managers (n=22) Teachers (n=136)	Electronic, structured survey	Statistical methods, content analysis (open questions)
3	4	IV	Cross-sectional, correlational survey	Structured instruments MCAF with integrated items from MCS (Grandell-Niemi 2005) and MNS (Veräjänkorva 2003) ILS (Vermunt 1998)	Nursing students at the beginning of studies 2nd semester (n=328), at the end of studies 7th semester (n=338)	Questionnaire, paper version or electronic version	Statistical methods

MECI= Medication Education Curriculum and Implementation instrument MEI=Medication Education Implementation instrument, MCAF= Medication Competence and Associated Factors instrument, MCS= Medication Calculation Skill instrument, ILS= Inventory of Learning Styles

4.1 Design, setting and sampling

4.1.1 Medication education in undergraduate nursing programmes

In study phase 2, a cross-sectional descriptive study design was used to describe the current medication education. Data were collected in spring 2010 (February - June) from all schools (N=23, n=21); Åland was excluded. Two of the schools were excluded from data collection from teachers do to the requirements of study protocol. Data were collected with two electronic questionnaires: one targeted at programme managers responsible for curriculum development and implementation (N= 33, n=22, RR 78%) and the other at teachers (N= 252, n=136, RR 54%) involved with medication education in different semesters of nursing studies.

A link to the electronic questionnaire (Medication Education and Curriculum Implementation, MECI) was first sent by e-mail to managers of undergraduate nursing programmes. The managers were then asked, in addition to participating in the study, to provide contact details of teachers representing the following teaching areas: pharmacology, medication management, internal nursing (including gerontological nursing), surgical nursing, perioperative nursing, mental health nursing (including substance addiction), paediatric nursing and acute/intensive care nursing. After receiving the contact details a link to the electronic questionnaire (Medication Education and Implementation, MEI) was sent to teachers by e-mail, and the teachers were asked to answer the questionnaire based on their own area of teaching.

4.1.2 Medication competence of nursing students and associated factors

In study phase 3, a descriptive, correlational study design was used to evaluate medication competence of nursing students and factors associated with the competence. The approach (Figure 5) to evaluation of medication competence of nursing students was based on a number of previous empirical studies (I, II).

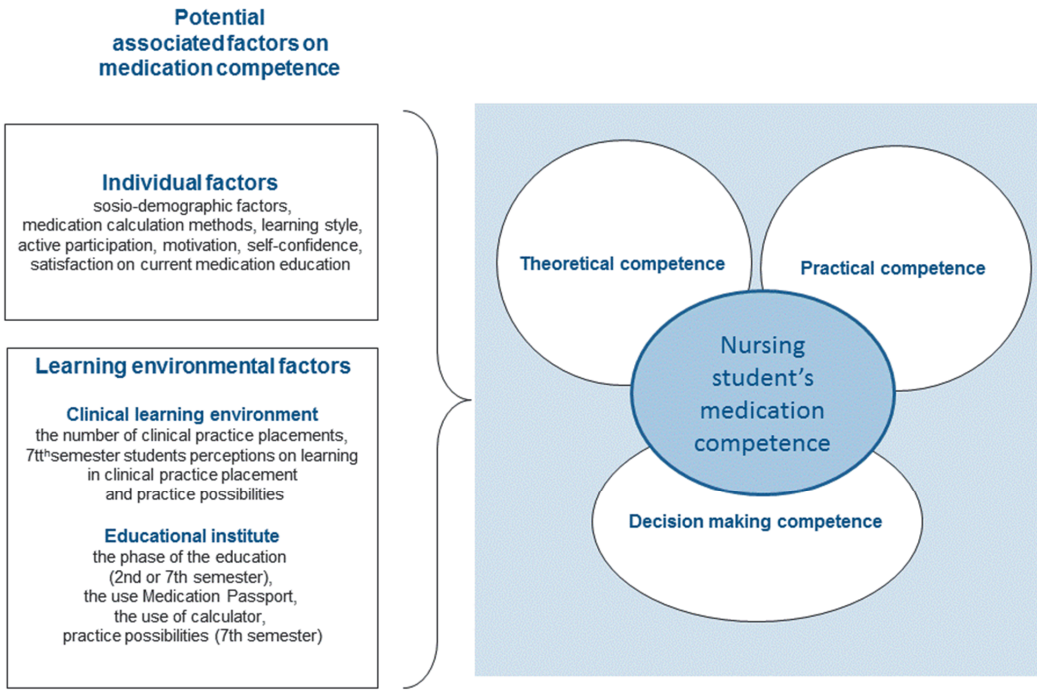

Figure 5. Theoretical framework of the evaluation on medication competence of nursing students

Data were collected with either an electronic or a paper version of the questionnaire from 12 out of 23 schools in Finland representing different geographical areas and school sizes. Participants consisted of two convenience samples: nursing students at the beginning (2nd semester = 328) and end of the bachelor education (7th semester n =338). The purpose of the use of two samples was to identify the development of medication competence during education and explore the relationship between the number of clinical practice placements and working experience on medication competence. The 2nd semester students had participated in basic education on pharmacology and medication management but had limited experience from clinical practice. The 7th semester students had studied more clinical pharmacology, and had experience from several clinical practice placements.

Sample size calculations with significance level 0.05 and power 0.80 were based on the instrument of Grandell-Niemi's (2005) study and pilot study (n=69) giving a minimum amount of 300 students in both groups. Data collection was mainly conducted in supervised situations. In the final sample, 19% (n=126) of the students had a calculator in use. The students had up to 90 minutes for answering. The response rate

varied from 100% to 27% between the schools, and the total response rate was 51% (n=666, N=1,314). The data collection took 18 months (2011–2012) before the required minimum amount of students in both groups was achieved.

4.2 Instruments

For the description of current medication education in undergraduate nursing education two instruments were developed based on a literature review and by using an expert panel: 1) Medication Education Curriculum and Implementation [MECI] targeted at managers of undergraduate nursing programmes (Appendix 1A) and 2) Medication Education Implementation [MEI]) targeted at teachers (Appendix 1B).

The development and selection of the instrument for evaluating nursing students' medication competence and associated factors was based on two literature reviews (I, II) and the use of an expert panel. The Medication Competence and Associated Factors [MCAF] instrument was developed for this study. Items from the Medication Calculation Skill Instrument (MCS, Grandell-Niemi 2005), the instrument Medication Skills of Nurses (MSN, Veräjänkorva 2003) and part of the Learning Style Inventory (ILS, Vermunt 1998) translated to Finnish and validated in Finland (Lonka & Lindblom-Ylänne 1996, Heikkilä 2005) were integrated into the MCAF instrument. The MCAF questionnaire is not published as appendix to ensure validity of the instrument in future studies and to avoid re- publishing of previously developed instruments. In this study, patient vignettes were introduced for evaluation of nursing students' decision-making competence. Patient vignettes have previously been used to evaluate nurse prescribers' decision-making competence (Offredy et al. 2008). The patient vignettes provided a possibility of measuring how the students would act and make decisions about patients care in a given situation (Van Eerden 2001). All the instruments were pilot tested before data collection. The overall instrumentation of the study is shown in Appendix 2.

4.3 Data analysis

The data were analysed using the Statistical Package for the Social Sciences (IBM SPSS statistics version 20) and SAS for Windows (version 9.1). Descriptive statistics, including percentages, mean values, standard deviations and ranges (min-max), were used to summarize the information gathered. Sum scores were formed on the content of medication education (MEI). In the student data, sum scores on self-confidence in medication administration, active participation on studying topics of medication care, Self-regulation,

External-regulation and Lack of regulation in learning were formed. To analyse significant differences between the samples in study phases two and three, a variety of statistical methods were used (Table 6).

Table 6. Statistical tests used in study phases 2 and 3

Purpose	**Study phase**	**Statistical test**
To describe the characteristics of the data and mean scores	2, 3	Descriptive statistics (percentages, mean values, standard deviations and ranges)
To compare perceptions of nursing programme managers and teachers	2	Mann-Whitney U- test
To evaluate and compare the medication competence of nursing students	**3**	**First**, the normality of distributions by Shapiro-Wilk test **Second**, descriptive statistics **Third,** exploration of differences between the two groups, Chi-square or Fishers exact test; t-test or Mann-Whitney U-test; One-way analysis of variance ANOVA or Kruskal-Wallis **Fourth**, exploration of interrelationships between interval variables, Pearson and Spearman correlation analysis **Fifth**, for analysis of statistically significant differences between the groups' independent-samples t-test, ANOVA and Pearson Chi-Square and in ordinal data Mann-Whitney U test
To identify presence of statistically significant explanatory variables	3	Regression analysis, Standard multiple regression analysis

4.4 Ethical considerations

The research was conducted following ethical guidelines in all the phases of the study (Finnish Advisory Board on Research Integrity TENK 2012). For evaluation of medication education in undergraduate nursing programmes, permission to the study was granted by each of the participating school. Participants were informed about the study before the link to the questionnaire was provided. Participation was voluntary. Privacy of the respondents was protected by not linking participants' e-mail addresses to the data analysis. Answering the questionnaire was seen as consent to participate the study.

For evaluation of nursing students' medication competence and associated factors, ethical approval was given by the Ethical Board of the University of Turku (Statement 7/2010, 20.4.2010) and the permission for the study was granted by all of the participating schools. Participation was voluntary and anonymous. Confidentiality of the data was assured. Students were asked to give their contact details if they wanted to participate in a lottery arranged for the participants. Students' contact details were collected separately and deleted after lottery. All participants were given information about the study and its purpose. Answering the questionnaire was seen as consent to participate in the study. The permission to use previously developed instruments was obtained from the original developers before data collection. All the results of the data collected are reported in the original papers and summary.

5 RESULTS

Results of the two reviews (I, II) are reported as part of the background of the study (2.4). The empirical results are presented in two parts according to research questions: 1) findings of a national survey conducted to describe current medication education in undergraduate nursing programmes (III), and 2) findings of evaluation of medication competence of nursing students and associated factors (IV). The summary also includes previously unpublished material. Some of the results are therefore reported in more detail.

5.1 Medication education in undergraduate nursing programmes (III)

5.1.1. Curriculum content and implementation of medication education

The managers of undergraduate nursing programmes were asked to describe the conception (philosophy) of learning underlying the curriculum and the model of curriculum implementation. The conception of learning was most often constructivism (n=15 constructivism or socio-constructivism) and the delivery model of the curriculum was most often competence-based (n=13). The total amount of ECTS credits devoted to medication education was on average 9.4 ECTS (range 5 to 16). Some of the respondents commented on this question (n=5) that it is difficult or even impossible to estimate the actual amount of content in different courses. The teachers were also asked to evaluate how many teaching hours were devoted to basic medication and applied medication education in the own area of teaching. However, the teachers were not able to give numbers of teaching hours and therefore no conclusions on the actual amount of content can be drawn.

The managers were asked to estimate how many contact and self-directed hours there were on average per ECTS credit. However, the answers to this question varied between 24h to 50h per ECTS and therefore no conclusion could be drawn. The size of student group in theory lectures varied from 12 to 100 students and in skill laboratory classes from 10 to 20 students. The students had good possibilities to practice in different nursing settings (Appendix 3).

The core aspects of pharmacology and medication management were mainly implemented as both a separate course and integrated into other courses. Applied pharmacology was most often integrated to other courses. Medication education was mainly delivered by nursing teachers. All of the topics of medication education provided in the MEI questionnaire got at least some emphasis in the content of teaching by the teachers (Appendix 4). However, less emphasis was put on the theoretical basis of medication care than, for example, medication calculation education. (III)

5.1.2 Teaching and evaluation methods used in medication education

There was variation in the teaching and evaluation methods used in medication education. The three most commonly used teaching methods were lectures, skill laboratories and individual written assignment. In students' self-directed learning time web environments and written assignments were most often used. The three most often used evaluation methods were written examinations, performance tests and written assignments and the use of the Medication Passport. Nursing students' medication competence was evaluated regularly by using a variety of methods, such as written examinations and medication calculation tests (III).

5.1.3 Development needs of teaching material used in medication education

Teachers were asked with open-ended questions to provide their opinions on current teaching materials used in medication education and the development needs of the material. These questions were relevant only for teachers involved with practice in a classroom or simulation environment. Ninety-two teachers answered the question on current materials used in practicing medication administration (per oral and intravenous medication). In all of the schools saline fluid (n=72) and placebo medicines (inside a genuine medicine package) were most often used as teaching materials. Nine of the teachers had been using out of date infusions and medicines. Teachers used their imagination in planning practices in the classroom and used for example sweets and sugar as replacement for medicines and self-made labels for medicines to practice with.

All the schools had similar equipment for handling and preparing medicines, dividing per oral medicines into patient doses, practicing medicine administration via different routes and safe disposal of medicines and equipment. Most had technical equipment used in medication administration available, such as infusion pumps, perfusors and PCA pump. Thirteen of the teachers mentioned using mannequins in practicing

medication administration and setting an iv cannula. Five of the teachers mentioned different medicine information sources being available for practice, and in four schools, demo hospital record systems were available.

Eighty-four teachers answered the question on development needs of teaching material used in medication education. Nine teachers expressed satisfaction with current teaching materials and equipment. Having modern and updated facilities and enough equipment was seen as important by fifteen of the teachers. Teachers (n=14) wished to get a separate medication room and sophisticated simulation environments to practice with authentic hospital record systems (n=3). Virtual and Internet-based learning environments were seen as a method for the future to increase the time spent on self-regulated learning (n=9). Fifteen of the teachers expressed a need for placebo medicines (tablets, capsules, ampoules and vials) with authentic medicine labels. Although it was not mentioned in the question, ten of the teachers expressed a need for more time devoted to practice in the classroom. In addition, the teachers were asked to select tasks and equipment related to medication management possible to practice in school facilities *(*Appendix 5).

5.2 Medication competence of the nursing students and associated factors (IV)

Background of the responding students

Of the nursing students, 89% (n=593) were female and 11% (n=70) male. Their age varied between 19 and 55 years (mean age 25 years). Most of the students had completed upper secondary school (65%) and a short syllabus in mathematics (41%). Twenty-two per cent of the students had a previous degree in nursing. The 2nd and 7th semester students' educational background were very similar. On average, the 2nd semester students had had one and the 7th semester students seven clinical practice periods. Both groups of students had on average 12.5 months working experience in health care before entering the undergraduate nursing programme. The 7th semester students had on average 3.8 months of working experience as registered nurse substitutes during their education. (IV)

Most of the students used nursing formula in solving medication calculations (60%), 29% used deduction as a method, and the ratio-portion method was used only by 5%. Most of the students verified their results in medication calculations by using another method of calculation sometimes (66%), always (26%) or never (8%). Most of the students (85%) evaluated whether their result could reasonably be correct.

Students' perceptions on learning medication management in clinical practice placements were asked from the 7th semester nursing students. Overall, the students had positive experiences from clinical practice (Appendix 6). Perceptions on supervision and practice possibilities were especially positive. The students were less positive about the integration of theory and practice and the support provided by the teacher. The students were also critical towards the utility of the Medication Passport. The 7th semester students were also given a list of different nursing skills, tasks and equipment used in medication management and asked to mark what skills, tasks and equipment they had had possibility to practice during their education. Overall, the students had had good practice possibilities (Appendix 7). However, 20% of the students had not practised medication calculations in the clinical practice placement.

5.2.1 Medication competence of nursing students (IV)

Overall medication competence of nursing students.

The average result in the overall (total) medication competence evaluation was 70% correct answers over the semesters, 68% for the 2nd semester and 72% for 7th semester students (IV), verifying development of medication competence during studies.

Theoretical medication competence of nursing students. None of the students achieved 100% correct answers in the knowledge test: 33% of the students (n= 220) achieved over 80% correct, while the mean score in both groups was 72% correct. There were differences between the students groups at the beginning and end of education. The average score of 2nd semester students was 71 % and that of 7th semester students 73% correct. The difference between the 2nd and 7th semester student groups was statistically significant only at sub-score level. Descriptive statistics on the proportion of wrong answers, I don't know answers and missing answers revealed that the most difficult items on the evaluation of theoretical medication competence were the groups' pharmacological questions, with a few exceptions both at the beginning and end of the studies (Appendix 8).

Practical medication competence of nursing students. In both groups, 17% of the students were able to calculate all ten medication calculation tasks correctly, the mean score being 74% correct. There were differences between the student groups at the beginning and end of education. The average score of 2nd semester students was 73% and that of 7th semester students 76% correct answers. The difference between the 2nd and 7th semester student groups was statistically significant only at sub-score level. The calculation

of liquid dilutions and calculation of the infusion rate in drops per minute was the most difficult for both student groups both at the beginning and end of the studies (Appendix 8).

Decision-making competence of nursing students. Only four of the students chose all the best choices for action, the mean score being in total 57%. However, the minimum acceptable score was achieved by 84% of the students. There were significant differences between the student groups at the beginning and end of education. The 2nd semester students chose the best choices for action on average in 51% and the 7th semester students in 62% of the cases. The minimum acceptable score was achieved by 78% of the 2nd semester and 91% of the 7th semester students, confirming the development of competence during education. The most difficult patient case was a patient with hepatic insufficiency in need of pain relief (Appendix 8). There were also difficulties in identifying a digoxin overdose and choosing best actions in advising a diabetes patient on insulin dose, advising patients on the use of an antibiotic that can cause an antabus reaction with alcohol, and advising a mother with a infant having a fever over 38.0°C. In the vignette in which the patient had lost the medicine package information leaflet, half of the students choose to use medicine information sources for patient education that are targeted at health care professionals, not at consumers. The students were best able to solve the asthma patient vignette.

5.2.2 Factors associated with nursing students' medication competence

Several univariate factors were statistically associated with nursing students' medication competence areas (IV). Most of the factors identified were individual factors, some of them factors that nurse educators cannot influence, such as age, gender and semester (Figure 6, Appendices 9-10). Students' method of calculation was not associated with any results of the medication calculation test. The second-semester students who had a prior degree in nursing were able to solve the provided patient vignettes better ($p=0.05$) and answered "I don't know" less often. However, a prior degree in nursing when the student never completed upper secondary school had a negative association with the results in the medication calculation test ($p<0.05$). The students with long syllabus in mathematics achieved higher scores, also when compared with students with short syllabus ($p<0.001$).

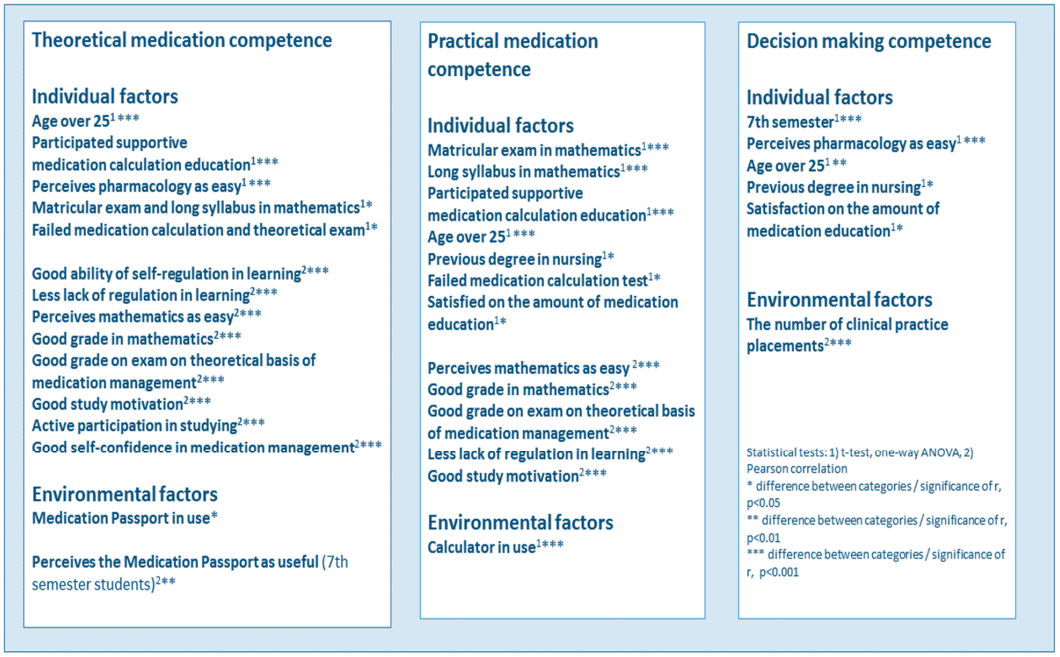

Figure 6. Individual and environmental factors associated with nursing students' medication competence areas

Among the environmental factors, there was a positive association with practice possibilities and the use of the Medication Passport and theoretical medication competence ($p<0.05$). The students' school had an association especially with performance on the medication calculation test (Appendix 11). The difference was, however, significant only in the 7th semester in the medication calculation test.

When looking at the 7th semester nursing students' perceptions of learning medication management and medication care in clinical practice placement, two statistically significant relationships were found. Students perceiving that the Medication Passport supported their learning in clinical practice achieved higher scores in the knowledge test ($p<0.05$, r 0.17). The students who perceived they had had possibilities to apply their knowledge during clinical practice also achieved higher scores in the knowledge test ($p<0.05$, r 0.11). Twenty per cent of the 7th semester students had not practised medication calculations in the clinical practice placement. These students also achieved lower scores in the Medication calculation test ($p<0.05$).

A standard multiple regression with backward elimination was conducted to identify the independent explanatory variables of medication competence areas of the two groups (Appendices 12A-12F) and potential differences between the two groups. A previous nursing degree was positively associated with 2nd semester

students' theoretical medication competence and decision-making, but had a negative association with the 7th semester students' practical medication competence. Perception of pharmacology as easy had significance for the 2nd semester students but not for the 7th semester students. Study motivation was significant only for the 7th semester students. The Medication Passport was an independent factor for 2nd and 7th semester students in theoretical medication competence. Perception of pharmacology as easy and previous degree were independent factors with the 2nd semester students. Lack of regulation in learning was the only independent explanatory factor of decision-making competence of 7th semester students.

To determine the set of independent explanatory variables on overall (total) medication competence of nursing students, standard multiple regression with backward elimination was applied. A summary of the independent determinants of the total medication competence is presented in Figure 7 (IV).

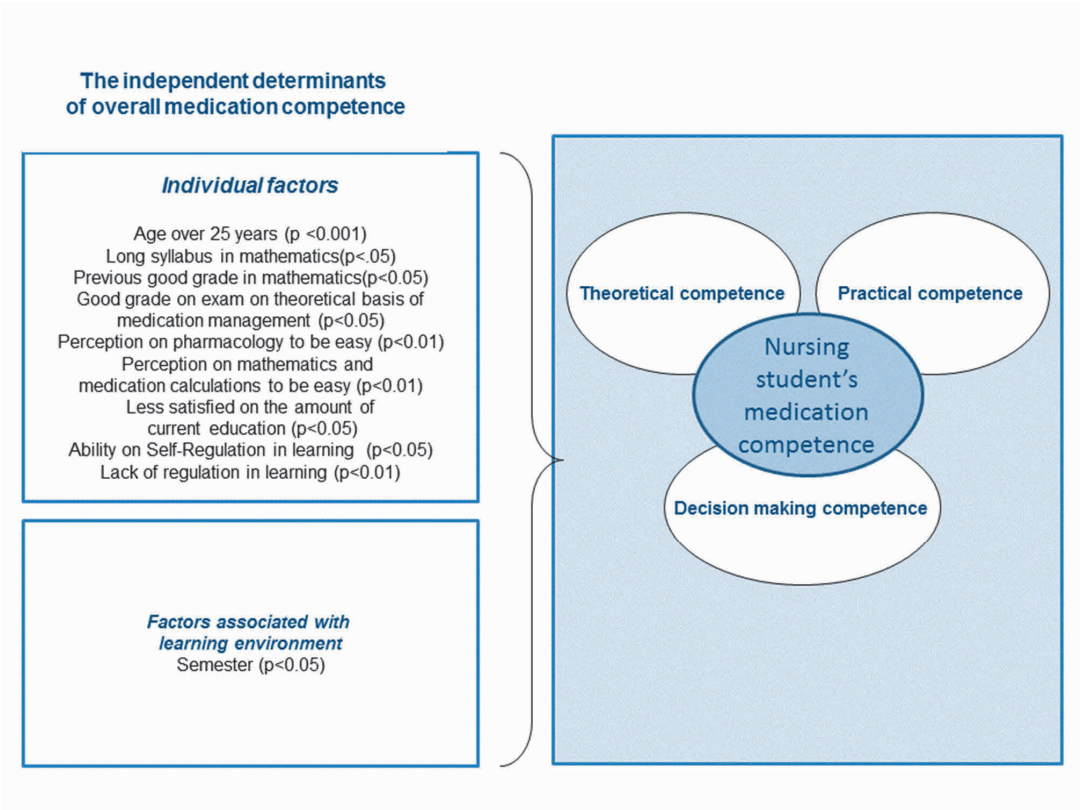

Figure 7. The independent determinants of the overall (total) medication competence of nursing students (n=594, % correct answers)

Further evaluation of the factors associated with medication competence areas was explored using standard multiple regression models (Appendices 13-15). Starting with all univariate significant variables, standard multiple regression with backward elimination was applied to determine the set of independent explanatory variables. The independent determinants of the performance in theoretical medication competence evaluation were individual factors, with the exception of the use of the Medication Passport. The independent determinants of performance in practical medication competence evaluation were individual factors, and among the environmental factors, the use of a calculator. In the evaluation of decision-making competence, the independent determinants were individual factors and among the environmental factors, semester. Cross-analysis of the sum-scores of medication competence areas shows a significant interrelationship ($p<0.001$).

Finally, a cross-evaluation between the students in the lower quartile and higher quartile of results on the overall (total) medication competence evaluation was conducted (Figure 8). Students' previous grade in mathematics and participation in supportive education were more significant associated factors among the 2nd semester students, while students' age, ability for self-regulated learning and study motivation were more significant associated factors among the 7th semester students.

Figure 8. Factors associated with nursing students' medication competence at the beginning and end of studies based on the weakest and highest results in the two groups. (Picture © Sulosaari)

6 DISCUSSION

The aims of this study were to describe the current medication education in undergraduate nursing, evaluate the medication competence of nursing students, and identify factors associated with the medication competence for future development of educational preparation of nurses in the clinical competence field closely related to the safety of patient care. In this chapter, discussion on the validity and reliability of the study and the main findings is provided.

6.1 Validity and reliability of the study

The validity and reliability of the study was ensured during the different study phases of the study. However, there are some critical observations and limitations related to the study.

Validity related to sampling, data and research process

The development process of the MECI and MEI questionnaires involved a literature review, an expert panel round and pilot testing of the instruments, which increased the validity of measurements. The development and selection process of instruments (MCAF, MCS, NMS, ILS) for evaluation of students' medication competence and associated factors also consisted of the phases of literature review, expert panel round and pilot testing. The content-related validity of the instruments can therefore be evaluated to be adequate.

The sampling in the *second phase of the study* on current medication education covered almost all of the schools (UAS) in Finland in the year 2010. The sample represented well the schools at the current time. However, five years have passed since the data collection and there may have been changes in nursing education after the survey. The response rate among the managers of nursing programmes was good (78%) while the response rate among teachers was lower (54%). Email questionnaires were used for data collection, and the limitation of email questionnaires is often a low response rate (Jones et al. 2008). However, using email questionnaires enabled data to be collected from nearly all of the Finnish schools. There were also indications that in some of the schools the MEI survey had also been sent to teachers not involved in medication education, such as language teachers. In some of the schools the data collection was delayed close to the summer, which may have had an impact on the low response rate of the teachers. However, the participating teachers represented different schools and different areas of nursing education quite well, and the aim was not to compare the content of medication education between the schools.

The convenience sampling in the *third phase of the study* on nursing students' medication competence and associated factors was based on power analysis and the representative sample size for statistical analyses was achieved, increasing the validity of the analysis. The low response rate (51%) has to be taken into consideration when generalizing the results. Due to a long data collection period control over possible changes in nursing education was not possible. The sample represented well students with different socio-demographic factors, schools and overall number of nursing students in Finland. However, survey as a method of data collection allowed a limited perspective on medication competence of nursing students. Registered nurses' medication competence also includes competency areas not explored in this study, such as interdisciplinary collaboration and communication. However, it is not possible to cover all competency areas in one survey. Thus, to explore areas such as communication skills, other methods would be preferable.

There were two different samples of nursing students in the study. In order to gain a deeper understanding of the development of students' medication competence, it would be a good idea to use a longitudinal research design and follow the same students through their education. However, this study provided more insight into nursing students' medication competence and identified factors associated with the competence in the two groups.

The students' data were collected either with an electronic or a paper version of the questionnaire, mainly in a supervised situation; only 114 nursing students responded unsupervised. When comparing the groups with or without supervision, only one statistically significant difference was identified. The students achieved higher scores on the knowledge test when they were not supervised. In the group without supervision the mean score on the test was 77% correct answers and in the supervised group 71%, indicating the use of Internet or other materials in answering. There was also significant difference between the students who had a calculator in use (19%) in the results in the medication calculation test. These limitations must be kept in mind when interpreting the results.

Validity and reliability of the instruments

Based on the systematic phases of instrument development (literature review, expert panel and pilot study), the content-related validity of both instruments used in the description of current medication education was considered adequate. On the Sum scores of the MEI questionnaire (Appendix 16) the internal consistency was estimated to be adequate by Cronbach's alpha calculated for sum variables (0.77- 0.95). Especially, the MEI instrument was long and detailed. In the future, the validity of the MEI instrument could be enhanced by re-evaluating the content with a new expert panel round also including representatives from clinical practice. The programme managers or the teachers were not able to evaluate the actual amount of the

medication education integrated into the curriculum. In the future, it is necessary to consider potential other ways to identify the actual amount of education devoted to the topic.

The MCAF instrument was used in the study for first time and future validation is still necessary; this is especially true with the part evaluating students' perceptions on learning in clinical practice. However, the partial use of previously developed and validated instruments increased the validity and reliability of the study (Vermunt 1998, Veräjänkorva 2003, Grandell-Niemi 2005). The internal consistency of the instruments used in this study was evaluated using Cronbach's α which showed adequate reliability in all dimensions (Appendix 17) with the exception of External Regulation sum score. The External Regulation in learning score showed lower reliability than in previous studies (Lonka & Lindblom-Ylänne 1996, Heikkilä 2005) and needs further validation.

The students had only up to 90 minutes for answering; the actual answering time varied between 20 to 90 minutes. However, the overall instrument was long, especially with the 7th semester students. This might have caused selection of more "I don't know" answers or leaving some of the questions unanswered in the medication competence evaluation. Some of the students may also have answered only questions they were comfortable or familiar with. In the future, the validity and reliability of the MCAF instrument could be increased by shortening the questionnaire and by using an expert panel consisting of representatives from schools and clinical practice.

Caution also needs to be taken when generalizing the results of the medication calculation test since calculation tasks were on paper and multiple choice answers were used instead of open answer calculation. Medication calculation tasks in paper form have been criticized by Hutton (1998) and Wright (2009) as they only mimic the authentic situations in nursing practice without the tools used in practice such as syringes. Multiple choice answers also made guessing possible; however, the use of the "I don't know" choice increased the validity of evaluation.

6.2 Discussion of the results

6.2.1 Medication education in undergraduate nursing programmes (III)

This study provided a national overview of medication education curriculum and implementation in the year 2010. The data allowed a more detailed description than previously of the medication education in undergraduate nursing programmes in Finland. The results of this study are also relevant internationally since the problems with medication education are similar internationally regarding concerns of variation in medication education (Morrison-Griffiths et al. 2002, Hemingway et al. 2011, Fleming et al. 2014).

The estimation of the amount of ECTS credits devoted to medication education in curricula varied between the schools, as described also in earlier studies (Latter et al. 2001, Manias & Bullock 2002a, Morrison-Griffiths et al. 2002, Dilles et al. 2011). The difficulties in identifying the actual content and amount of medication education calls attention to the structures of curriculum implementation models. Undergraduate nursing curricula is competence-based and therefore aiming at competence outcomes in education. To address how undergraduate education prepares nursing students to the competence goals of education, the schools need to consider ways of identifying relevant content and amount of education.

The universities of applied sciences in Finland have autonomy in their curricula and the European Union legislation gives only a general framework to nursing education. Continuing the efforts for national collaboration in medication education development are therefore needed. A minimum of nine ECTS credits as basis of medication education should be the minimum goal for all of the nursing programmes (The Finnish Ministry of Education, 2006). In 2015, the National Health Care Network of Universities of Applied Sciences and Finnish Nurses Association (Ammattikorkeakoulujen terveysalan verkosto ja Sairaanhoitajaliitto 2015) published descriptions of the professional competence of a nurse responsible for general care. In the publication, medication competence is positioned as part of clinical nursing competencies and no recommendation on the amount of the medication education is provided. Recently, new national guide on Safe Pharmacotherapy (Terveyden ja hyvinvoinnin laitos 2016) was published. It may provide some support for the development of medication education in undergraduate nursing programmes.

It appears that the content of teaching is quite comprehensive in Finland. A lot of emphasis has been put especially on medication calculation education. This emphasis is important; however, it is only one part of the overall medication education. There was least emphasis on the theoretical principles of medication care. This result is worrying, since an understanding of the practical aspects of pharmacology is essential in order to be able to gain an understanding of medication management and medication care of different patient groups (Manias & Bullock 2002a, 2002b, Morrison-Griffiths et al. 2002, Manias 2009). In the light of the

ageing society, the amount of self-treatment medicines available and the need for medication patient education in the use of these medications, more emphasis should also be given on this topic.

The schools were not compared in terms of the content of medication education. However, in order to ensure the medication competence of graduating nursing students, the undergraduate nursing programmes need to increase collaboration between the schools and create a shared understanding of the core content of medication education. In terms of nurse workforce immigration there is also a need to ensure the educational preparation of nurses within the European Union. Although registered nurses' role and education varies in the European Union countries, the general directives and guidelines are the same. Therefore, as has also been suggested by Salminen et al. (2010), there is a need for more research in the field of nursing education.

A review of nursing curricula and a reorganization of the educational framework could improve the medication competence of nursing students, improve their confidence in drug management and facilitate skills in educating about medications (Aggar & Dawson 2014). In Australia, in a study by van de Mortel et al. (2014), a positive change was shown in numeracy skills applied by nursing students when the curriculum implementation was changed to a whole-of-curriculum approach. The core content of medication education (Table 2) could be useful for developing a national framework and for enhancing the implementation of medication education as a whole-of-curriculum approach. Collaboration between the schools and clinical practice placements is also necessary for the development of a national framework to ensure provision of a relevant and contemporary content of medication education during nurses' basic education (Bullock & Manias 2002, Manias & Bullock 2002a, Bourbonnais & Caswell 2014, Aronsson et al. 2015). Efficient, cost-effective and structured methods to support learning and integration of theory and practice are warranted to avoid problems with over-laden curricula and expensive curriculum implementation. One example of these is the national Medication Passport used in Finland.

Supporting practice possibilities, regular follow-up and evaluation of medication competence is necessary to improve nursing students' medication competence prior to graduation to profession, as has been suggested by Mettiäinen et al. (2014). Regular update-education and verification of medication competence of nurses has also been identified as an efficient method to ensure the medication competence of registered nurses (Sneck 2016). Therefore, in addition to the use of the Medication Passport as a tool, a national examination at the end of education could be an effective method for ensuring the medication competence of graduating nursing students.

Who should teach medication education? There has been some public discussion nationally and internationally on the competence of nurse teachers to teach this topic, especially pharmacology. Medication education was indeed most often delivered by nurse teachers in this study, as has been seen in previous

studies as well (Latter et al. 2001, Morrison-Griffiths et al. 2002). The nurse teachers' role is to foster the development of conceptual and contextual understanding in relation to nursing practice (Hunter Revell & McCurry 2013). The strength of nurse teachers has been argued to be in their ability to integrate theory with the actual nursing practice (Morrison-Griffiths et al. 2002). However, medication care is based on interdisciplinary communication and collaboration. Therefore the development of medication safety and education would benefit from multidisciplinary collaboration (Choo et al. 2010, Leufer & Clearly-Holdforth 2013) and it would be optimal to combine the strengths of teachers form different disciplinary backgrounds. In some of the schools there were also pharmacists, physicians and mathematicians. However, the economic situation of the schools has decreased the use of mathematicians, physicians and pharmacists. As the competence of teachers is related to the provision of medication education, consideration of possibilities of these teachers to update and develop their knowledge is needed in order to increase the quality of medication education. Therefore further research on the current further education possibilities of nurse teachers and the methods of interdisciplinary teaching is warranted.

The need to develop the teaching materials to mimic the complex real-life medication management activities of nurses is evident. Medication management has become more and more technology-driven, and teachers need contemporary equipment and teaching versions of electronic patient and medication records to provide efficient and meaningful education (Krautscheid et al. 2011, Orbæk et al. 2015). Thus, there are challenges in purchasing contemporary teaching materials in the current economic climate.

6.2.2 Medication competence of nursing students' and associated factors (IV)

Nurses need adequate medication competence to be able to provide safe medication care to their patients. They also have an important role in patient education and in supporting patients' adherence to medication care. The medication competence, especially the medication calculation and numeracy skills, of nursing students has been a concern for many years. In this study, more evidence was provided on nursing students' medication competence and the factors associated with it.

The main results indicate some deficiencies in students' medication competence although the results are better than in several international studies (Dilles et al. 2011, Eastwood et al. 2011, Ramjan et al. 2014.) However, there is only a minor improvement in pharmacological knowledge and medication calculation skills since the Grandell-Niemi et al. (2005, 2006) study. Medication competence development during education is evident and therefore does not support the findings of Cinar et al. (2006) of medication calculation skills being better at the beginning of education.

The students perceived themselves to be generally well-motivated and active in participating in medication education. In contrast to prior studies, the students in this study perceived themselves as self-confident in medication management at the end of their education (Grandell-Niemi et al. 2001, 2005, 2006, Wright 2004, Honey & Lim 2008, Dilles et al. 2011). However, the result is similar to findings of recent studies by Hemingway et al. (2011) and Simonsen et al (2014). Self-confidence in medication management increased during the studies, and upon graduation the students were quite confident to assume their professional role in the multidisciplinary team responsible for patients' medication care.

Possibilities to practice skills relevant to the delivery of medication care are needed for the students so as to be able to become confident and competent in medication management (Manias & Bullock 2002, Grandell-Niemi et al. 2005, Honey & Lim 2008). Therefore, as nurses' medication competence is associated with patient safety, competence development needs to be supported and evaluated regularly during undergraduate education (Dilles et al. 2011). Overall, the 7th semester students in this study had good possibilities to practice different skills and tasks in medication management at the school facilities and clinical practice placements.

The students, however, perceived there to be less practice possibilities at the school facilities than the nurse teachers. Of the 7th semester students, 20% perceived that they had not practised medication calculations in the clinical practice placements. This result is worrying, since the students had an average of seven clinical practice periods. Is it so that the nurses do not perceive they are doing medication calculations in everyday work? The practising nurses might have embedded medication calculations within their practice, and might no longer recognize the presence of calculations in care of patients. As a result, students may fail to practise medication calculations in practice? Regular practice in medication calculations is important for the development and retention of adequate medication calculations skills (Grandell-Niemi et al. 2006, Wright 2006, McMullan et al. 2010, Dilles et al. 2011). Collaboration between the schools and clinical practice placements is therefore important to ensure adequate possibilities to practice.

Most evident relationship exists between students' competence and individual factors, as also supported by Hutton (1998), Grandell-Niemi et al. (2005, 2006), McMullan et al. (2010) and Ramjan et al. (2014). Students' educational background and academic success can be used to evaluate students' need for supportive medication education at the beginning of education. The more successful in previous studies, self-confident, motivated and active the student is, the better is the medication competence. Focusing on enhancing students' self-confidence and motivation could therefore improve the medication competence of nursing students.

Among the Individual factors, lack of regulation in learning had a negative association with all of the medication competence areas explored. Lack of regulation in learning was associated with overall medication

competence indicating a need to identify students who have difficulties in learning. More precisely, the results indicate students having difficulties to master the information load, self-regulate their own learning, and identify the most relevant content of the education and learning goals. In the future, it would be necessary to explore the relationships between nursing students' learning disabilities, lack of regulation in learning, and medication competence due to the growing number of individuals with learning disabilities among nursing students (Wray et al. 2013).

In the last decade, the emphasis of education has been moving towards self-directed learning methods instead of traditional classroom teaching. Nursing students are expected to be able to be self-directed in their learning (O'Shea 2003), but they do not always use the time for self-directed learning efficiently (Manias & Bullock 2002a). A more structured approach towards supporting the self-directed learning time is warranted. The results of this study indicate that at end of their education the significance of self-regulation abilities in learning increases. One reason for this might be the implementation of curriculum. At the beginning of their education students are more strictly guided and regulated than at the end of their education. Interestingly, in a recent study by Kim & Jang (2015) medical students showed an increase in motivation and a decrease in self-regulated learning as they proceeded with their medical education. In the same study, medical students' test anxiety scores and self-regulation were negatively associated, indicating a need to create a learning environment aimed at lessening students' test anxiety to facilitate their use of cognitive and meta-cognitive strategies. In the future, in order to enhance medication competence development, it could be useful to develop methods to support students' abilities to regulate their own learning.

There were two independent determinant factors associated factors with students' theoretical medication competence which are difficult to explain. These factors are the grade in mathematics and participation in supportive medication calculation education. These results can be a coincidence when having multiple variables. However, could it be so that the grade in mathematics is associated with logical thinking and reasoning and therefore also has an association with theoretical understanding? The same relationship was found by Grandell-Niemi et al. (2005). And when a student participates in supportive calculation education she also updates her knowledge on the theoretical aspects of medication management and pharmacology? Another interesting and possibly coincidental finding was that the students who were less satisfied with the current medication education achieved better results in the medication competence evaluation. Could it be that the more critical a student is towards education, the more critical she is also towards her own medication competence, and therefore more conscious of developing the adequate competence? In the study of Grandell-Niemi (2005), the more satisfied a student was with the current medication calculation education, the better the results. Thus, these relationships described above need further study.

Among the environmental factors, possibilities to practice and the number of clinical practice placements had a positive association with students' medication competence. However, the number of clinical practice placements was not an independent determinant of medication competence. Thus, the results of practice possibilities and the results of medication competence evaluation indicates that the clinical learning environment has an impact on competence development, which has also been highlighted by Grandell-Niemi et al. (2005, 2006) and Honey & Lim (2008). The role of nurse mentors is important for preventing medication errors during undergraduate education and for acting as role models for nursing students to learn issues related to medication management and safety (Murphy 2012, Andrew & Mansour 2014). However, the relationship between clinical practice and medication competence development requires further research.

One of the environmental factors related to the educational institution was the school (UAS). Differences were found in students' medication competence between the schools, as previously found by Grandell-Niemi et al. (2005). The differences in the results were significant at the end of education in the medication calculation test. This result might be due to the different curriculum. However, variations in medication education in the amount and content have been reported previously (Latter et al. 2001, Bullock & Manias 2002, Morrison-Griffiths et al. 2002, Dilles et al. 2011). Therefore, there is a need to collaboratively develop medication education on both national and international level.

Another significant relationship was seen between the use of a calculator and students' performance on the medication calculation test. The use of calculator decreases errors, as was the case in our study, but it does not guarantee a 100% accuracy rate in calculations (Shockley et al. 1989, Tarnow & Werst 2000, Kohz & Gowda 2010). In nursing practice, calculators are often used for verification, but nurses need to be able to solve medication calculations also in situations when calculators are not available. It can be assumed that the use of calculators could have an effect on nursing students' anxiety towards formal testing of medication calculation skills. However, students' math anxiety was not explored in this study. In future, it would be interesting to explore the relationship between math anxiety and the use of calculator. If the use of calculator reliefs stress and anxiety, then it would be reasonable to allow calculators after ensuring the development of conceptual understanding underlying medication calculations. However, it is important to promote nursing students' learning possibilities also without a calculator in order to support the development of conceptual understanding and not rely on calculators, as has also been suggested by McMullan et al. (2010, 2012).

The core elements of medication competence, including theoretical and practical medication competence and decision-making, are significantly interrelated, highlighting the need to provide medication education in an integrative manner to support students' overall medication competence development, as has also been recommended by Meechan et al. (2011) and van de Mortel et al. (2014).

6.3 Conclusions

Medication competence is a complex and multifaceted area of general clinical competence related to patient safety. Registered nurses' medication competence consists of theoretical, practical, and decision-making competence. Medication competence is interrelated and linked to the nurse's values and attitudes. It is also associated with the nursing setting and the individual situation of the patient.

In order to unify and ensure the quality of medication education, national collaboration between the schools (UAS) is necessary. Medication education needs to reflect the needs of society. In the curriculum, more emphasis on the theoretical principles underlying safe medication management is necessary. A national recommendation on the amount and core content of medication education could be useful; however, this requires commitment from all the universities of applied sciences.

The overall findings indicate deficiencies in nursing students' medication competence, and as it is associated with the safety of medication care, attention needs to be put on nurses' educational preparation. The core elements of medication competence, including theoretical and practical medication competence and decision-making, are significantly interrelated, highlighting the need to provide integrated and comprehensive medication education to support students' competence development.

The strongest association with students' medication competence exists between students' individual factors and medication competence. Developing methods to enhance students' self-confidence, motivation and abilities to self-regulation in learning could improve the medication competence of nursing students.

6.4 Suggestions for further research and to nursing education

According to the study suggestions for further research and nursing education are proposed in the Figure 9.

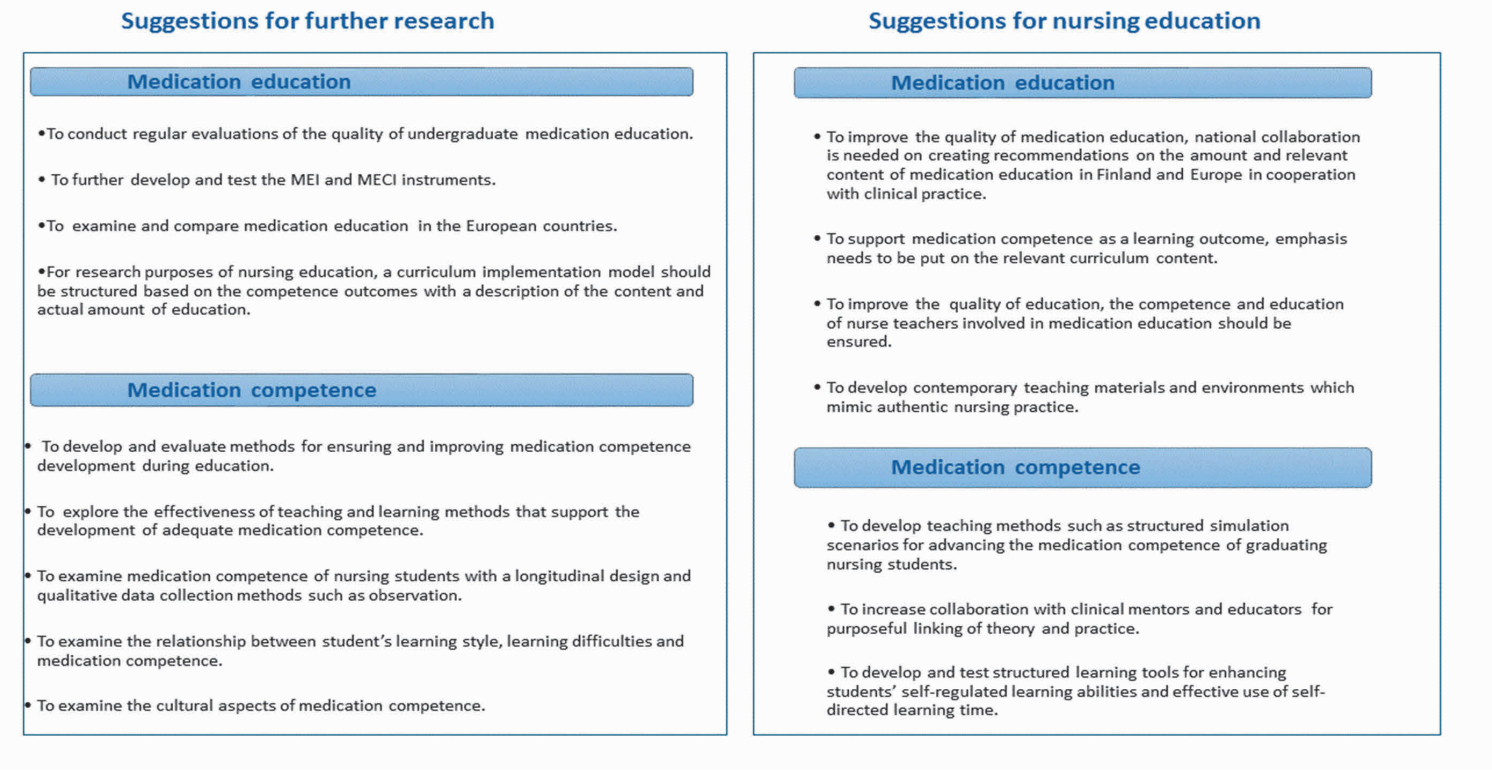

Figure 9. Suggestions for further research and nursing education

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Appendices

Appendix 1. Questionnaires used in the study

Appendix 1A. Medication Education Curriculum and Implementation (MECI) questionnaire

Lääkehoidon opetus sairaanhoitajan tutkintoon johtavassa koulutuksessa (koulutuspäällikkö)

Hyvä koulutuspäällikkö,
tässä tutkimuksessa selvitetään lääkehoidon opetuksen nykytilaa suomalaisissa ammattikorkeakouluissa sairaanhoitajan tutkintoon johtavassa koulutuksessa. Tämä koulutuspäälliköille kohdennettu kyselylomake koostuu kolmesta osasta: A) ammattikorkeakouluun liittyvät taustatiedot, B) opetussuunnitelma ja sen toteuttaminen ja C) oppimistulosten arviointi ja opetuksen integrointi harjoitteluun.

Vastaaminen kestää noin 20 min. Voit keskeyttää vastaamisen välillä ja jatkaa vastaamista myöhemmin. Vastattuasi kaikkiin kysymyksiin, lähetä vastauksesi painamalla LÄHETÄ -näppäintä viimeisellä sivulla.

A) Taustatiedot

Kirjoita vastauksesi sille varattuun tilaan tai valitse sopivin vastausvaihtoehto, osassa kysymyksiä on mahdollisuus valita useampikin vaihtoehto.

1. Montako toimipistettä, joissa on hoitotyön koulutusohjelma, on ammattikorkeakoulussasi ?

2. Paljonko ammattikorkeakoulussasi on vastaushetkellä opiskelijoita sairaanhoitajan tutkintoon johtavassa koulutuksessa ?

2. Paljonko ammattikorkeakoulussasi on vastaushetkellä opiskelijoita sairaanhoitajan tutkintoon johtavassa koulutuksessa ?

3. Paljonko sairaanhoitajaopiskelijoita on toimipisteessäsi vastaushetkellä?

4. Sairaanhoitajaopiskelijoilla on mahdollisuus suorittaa harjoittelujaksoja

- ☐ yliopistollisessa keskussairaalassa
- ☐ alue- tai keskussairaalassa
- ☐ terveyskeskuksessa
- ☐ erilaisissa perusterveydenhuollon toimintayksiköissä
- ☐ erilaisissa sosiaalihuollon toimintayksiköissä
- ☐ yksityisissä sosiaali- ja terveydenhuollon toimintayksiköissä
- ☐ ammattikorkeakoulun palvelu- tai työtoiminnassa
- ☐ muualla, missä

5. Järjestetäänkö ammattikorkeakoulussa hoitotyön koulutusohjelmaan hakijoille valintakoe, jossa arvioidaan hakijan matemaattisia taitoja?

◯ kyllä ◯ ei

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6. Mikäli vastasit edelliseen kyllä, kuvaile miten tietoa hyödynnetään opiskelijavalinnassa tai opintojen suunnittelussa

Seuraavassa kysytään lähiopetuksen ja itsenäisen opiskelun suhdetta sekä opiskelijaryhmän kokoa yleisesti ammattikorkeakoulussa. Voit antaa täydentäviä tietoja lisätietoja kohdassa.

7. Mikä on keskimääräinen opiskelijaryhmän koko

teoriaopetuksessa

luokassa tapahtuvassa harjoittelussa (laboraatio-opetus)

8. Kuinka monta tuntia opetuksesta on keskimäärin

Lähiopetusta / opintopiste

Itsenäistä opiskelua/opintopiste

9. Mikä on ammattikorkeakoulusi opetussuunnitelman taustalla oleva oppimiskäsitys (mikäli se on määritelty)?

10. Mikä on opetussuunnitelman/ opetussuunnitelman toteutuksen rakenteen tausta?

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Seuraavassa kysytään lääkehoidon opetuksen toteuttamismallia ja toteuttajia sairaanhoitajan tutkintoon johtavassa koulutuksessa. Voit antaa täydentäviä tietoja lisätietoja kohdassa.

Lääkehoidon perusteilla tarkoitetaan tässä tutkimuksessa lääkehoidon toteuttamisen yleisiä periaatteita: lääkehoidon toteuttamisen eettistä ja lakisääteistä perustaa, farmasian, farmakodynamiikan ja farmakokinetiikan perusteita, lääkelaskentaa, lääkehoidon ja nestehoidon sekä verensiirtohoidon suunnittelua, toteuttamista ja arviointia lääkehoitoprosessin eri vaiheissa sekä lääkehoidon ohjausta ja lääkehoitoon sitoutumisen tukemista yleisellä tasolla. **Soveltavalla lääkehoidon opetuksella tarkoitetaan** lääkehoidon yleisten periaatteiden soveltamista sairauksia omaavien potilasryhmien lääkehoidon suunnittelussa, toteutuksessa ja arvioinnissa niin, että kyseisen potilasryhmän ja/tai lääkeryhmän erityispiirteet otetaan huomioon (esim. verenpainepotilaan lääkehoidon suunnittelu, toteutus ja arviointi).

11. Miten **lääkehoidon perusteiden opetuksen** toteutus on opetussuunnitelmassa

- ◯ Erillisinä opintojaksoina
- ◯ Integroituna muihin opintojaksoihin
- ◯ Sekä omana opintojaksona että osin integroituna muihin opintojaksoihin

Lisätietoja

12. Miten **soveltavan lääkehoidon opetuksen** toteutus on opetussuunnitelmassa

- ◯ Erillisinä opintojaksoina
- ◯ Integroituna muihin opintojaksoihin
- ◯ Sekä omana opintojaksona että osin integroituna muihin opintojaksoihin

Lisätietoja

13. Lääkehoidon perusteita lukuunottamatta lääkelaskentaa opettaa

- ☐ Hoitotyön opettaja
- ☐ Farmasian alan opettaja (esim. proviisori)
- ☐ Lääkäri
- ☐ Edellä mainittujen alojen opiskelija
- ☐ Joku muu, kuka

Lisätietoja

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14. Lääkelaskentaa opettaa

- ☐ Hoitotyön opettaja
- ☐ Matematiikan opettaja
- ☐ Farmasian alan opettaja (esim. proviisori)
- ☐ Edellä mainittujen alojen opiskelija
- ☐ Joku muu, kuka

Lisätietoja

15. Soveltavaa lääkehoitoa opettaa

- ☐ Hoitotyön opettaja
- ☐ Farmasian alan opettaja (esim. proviisori)
- ☐ Lääkäri
- ☐ Edellä mainittujen alojen opiskelija
- ☐ Joku muu, kuka

Lisätietoja

Seuraavassa kysytään lääkehoidon opetuksen laajuutta sairaanhoitajan tutkintoon johtavassa koulutuksessa. Vastaa kirjoittamalla opintopisteiden määrä tai arvio opintopisteiden määrästä sille annettuun kohtaan (esim. soveltavan lääkehoidon osalta voi olla vaikea antaa tarkkaa laajuutta).

16. Mikä on seuraavien lääkehoidon opetuksen sisältöalueiden laajuus opintopisteinä

Lääkehoidon perusteet (ei lääkelaskenta)

Lääkelaskenta

Soveltava lääkehoito

Lääkehoidon opintojen kokonaislaajuus kattaen koko opinnot

Lisätietoja

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C) Oppimistulosten arviointi ja opetuksen integrointi harjoitteluun

Seuraavassa kysytään sairaanhoitajaopiskelijan lääkehoitoon liittyvien oppimistulosten arviointia ja menetelmiä ammattikorkeakoulussa tapahtuvan opetuksen integroimiseksi harjoitteluun.

18. Miten sairaanhoitajaopiskelijan lääkehoidon osaamista arvioidaan (ei lääkelaskenta)

- ☐ Kirjallisella kokeella
- ☐ Näyttö- tai taitokokeella
- ☐ Kirjallisella tehtävällä
- ☐ Jollain muulla, millä

Lisätietoja

Seuraavassa kysytään mielipidettäsi lääkehoidon opetukseen käytettävästä ajasta opetussuunnitelman toteuttamisessa. Vastaa valitsemalla omaa mielipidettäsi vastaava kohta. Voit antaa täydentäviä tietoja lisätietoja -kohdassa.

17. Lääkehoidon opetuksen toteuttamiseen käytettävä aika opetussuunnitelmassa

	1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei samaa eikä eri mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä
Lääkehoidon perusteiden opetukseen on käytettävissä riittävästi aikaa opetussuunnitelman toteuttamisessa	○	○	○	○	○
Lääkehoidon soveltavaan opetukseen on käytettävissä riittävästi aikaa opetussuunnitelman toteuttamisessa	○	○	○	○	○
Lääkehoidon opetukseen käytettävissä oleva aika mahdollistaa hyvin asetettujen oppimistavoitteiden saavuttamisen	○	○	○	○	○
Lääkehoidon opetus mahdollistaa sairaanhoitajaopiskelijan osaamisen kehittymisen riittävälle tasolle lääkehoidon turvallisen ja tehokkaan toteuttamisen näkökulmasta.	○	○	○	○	○

Lisätietoja

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19. Miten sairaanhoitajaopiskelijan lääkelaskentataitoja arvioidaan

- ☐ Erillinen lääkelaskutesti
- ☐ Jokaisessa hoitotyön kirjallisessa kokeessa on lääkelasku/-ja
- ☐ Jokaisella ohjatun harjoittelun jaksolla on lääkelaskutehtäviä
- ☐ Jollain muulla tavalla, millä

Lisätietoja

20. Miten sairaanhoitajaopiskelijan lääkehoidon osaamisen kehittymistä seurataan

- ☐ Ei seurantamenetelmää
- ☐ Lääkehoitopassi
- ☐ Portfolio
- ☐ Jokin muu, mikä

21. Miten usein sairaanhoitajaopiskelijan lääkelaskentataitoja arvioidaan

- ☐ Ei arvioida säännöllisesti
- ☐ Joka lukukausi
- ☐ Joka lukuvuosi
- ☐ Jokin muu, mikä

Lisätietoja

22. Miten lääkehoidon teoriaopetuksen integroitumista käytäntöön edistetään harjoittelujaksoilla?

- ☐ Kirjallisella oppimistehtävällä
- ☐ Muilla oppimistehtävillä, millaisilla
- ☐ Muuten, miten

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23. Miten sairaanhoitajaopiskelijan lääkehoidon osaamista arvioidaan harjoittelujaksolla?

- ☐ Kirjallisella oppimistehtävällä
- ☐ Lääkehoitopassin osasuorituksilla
- ☐ Arviointikeskustelulla
- ☐ Näyttö/taitokokeella
- ☐ Muuten, miten

Lisätietoja

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Appendix 1B. Medication Education Implementation (MEI) questionnaire

Lääkehoidon opetus sairaanhoitajan tutkintoon johtavassa koulutuksessa (opettajat)

Hyvä vastaaja,
tässä tutkimuksessa selvitetään lääkehoidon opetuksen nykytilaa suomalaisissa ammattikorkeakouluissa **sairaanhoitajan tutkintoon johtavassa koulutuksessa**. Kyselylomake koostuu neljästä osasta: A) taustatiedot, B) lääkehoidon opetuksen sisältö ja painotus, C) lääkehoidon opetusmenetelmät ja D) lääkehoidon oppimisympäristö.

Pyydän Sinua vastamaan oman opetuksen vastuualueesi näkökulmasta kysymyksiin. Vastaaminen kestää noin 20 min. Voit halutessasi keskeyttää vastaamisen välillä ja jatkaa myöhemmin. Vastattuasi kaikkiin kysymyksiin, lähetä vastauksesi painamalla LÄHETÄ -näppäintä viimeisellä sivulla.

A) Taustatiedot

Kyselylomakkeen tässä osiossa kysytään taustatietoja koskien vastaajan tehtävää ja opetuksen vastuualuetta ammattikorkeakoulussa tai sen toimipisteessä. Kirjoita vastauksesi sille varattuun tilaan tai valitse sopivin vastausvaihtoehto.

1. Tehtäväsi ammattikorkeakoulussa / ammattikorkeakoulun toimipisteessä (voit valita useamman vaihtoehdon)

- ☐ Yliopettaja
- ☐ Tutkintovastaava
- ☐ Lehtori tai päätoiminen tuntiopettaja
- ☐ Opintojaksosta/opintokokonaisuudesta vastaava opettaja
- ☐ Jokin muu, mikä

B) Lääkehoidon opetuksen laajuus ja sisällöt

Seuraavassa kysytään **lääkehoidon perusteisiin liittyvän opetuksen** sisältöä ja painotusta vastuualueesi opetuksessa. Opetuksen sisältöalueet on jaettu neljään laajempaan osa-alueeseen.

Kunkin sisältöalueen kohdalla arvioidaan sen painotusta omassa opetuksessa asteikolla 1 ei sisälly lainkaan opetukseen - 5 painottuu erittäin paljon opetuksen toteutuksessa. Lopuksi arvioidaan lääkehoidon opetuksen laajuutta oman opetusalueen/-alueiden opetuksen toteutuksessa.

3. Lääkehoidon perusteiden opetuksen sisällöt ja painotus

3a. Hoitotyön ammatillisen toiminnan lähtökohdat lääkehoidon toteuttamisessa

	1 Ei sisälly lainkaan opetukseen	2 Painottuu vähän opetuksen toteutuksessa	3 Painottuu melko paljon opetuksen toteutuksessa	4 Painottuu paljon opetuksen toteutuksessa	5 Painottuu erittäin paljon opetuksen toteutuksessa
Lainsäädäntö ja lääkehoito	○	○	○	○	○
Etiikka ja lääkehoito	○	○	○	○	○
Hoitotyön päätöksenteko lääkehoidon toteuttamisessa	○	○	○	○	○
Moniammatillinen yhteistyö lääkehoidon toteuttamisessa	○	○	○	○	○
Sairaanhoitaja lääkehoidon prosessin toteuttajana	○	○	○	○	○
Lääkehoitoon liittyvät tiedonlähteet ja niiden käyttö	○	○	○	○	○

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3b. Lääkehoidon teoriaperusta

	1 Ei sisälly lainkaan opetukseen	2 Painottuu vähän opetuksen toteutuksessa	3 Painottuu jonkin verran opetuksen toteutuksessa	4 Painottuu paljon opetuksen toteutuksessa	5 Painottuu erittäin paljon opetuksen toteutuksessa
Ihmisen anatomian ja fysiologian yhteys lääkkeen annosteluun	○	○	○	○	○
Lääkkeiden vaikutus kehon normaaliin toimintaan	○	○	○	○	○
Lääkkeiden antamisen eri reitit	○	○	○	○	○
Lääkkeiden kehittäminen	○	○	○	○	○
Lääkkeen ominaisuuksien ja rakenteen yhteys vaikutuksiin	○	○	○	○	○
Lääkemuodot	○	○	○	○	○
Lääkepakkaukset	○	○	○	○	○
Keskeiset farmakologiset käsitteet ja lyhenteet	○	○	○	○	○
Farmakodynamiikan perusteet	○	○	○	○	○
Farmakokinetiikan perusteet	○	○	○	○	○
Toksikologian perusteet	○	○	○	○	○
Lääkelaskennan matemaattiset perusteet	○	○	○	○	○
Lääkehoito lapsipotilailla	○	○	○	○	○
Lääkehoito ikääntyneillä	○	○	○	○	○
Lääkehoito munuaisten vajaatoimintapotilailla	○	○	○	○	○
Lääkehoito maksan vajaatoimintapotilailla	○	○	○	○	○
Lääkehoito raskauden tai imetyksen aikana	○	○	○	○	○

3c. Lääkehoidon toteuttaminen lääkehoitoprosessin eri vaiheissa

	1 Ei sisälly lainkaan opetukseen	2 Painottuu vähän opetuksen toteutuksessa	3 Painottuu jonkin verran opetuksen toteutuksessa	4 Painottuu paljon opetuksen toteutuksessa	5 Painottuu erittäin paljon opetuksen toteutuksessa
Lääkkeiden tilaaminen	○	○	○	○	○
Lääkkeiden säilyttäminen	○	○	○	○	○
Lääkkeiden käsittely ja hävittäminen	○	○	○	○	○
Lääkkeen käyttökuntoon saattaminen	○	○	○	○	○
Lääkemääräykset	○	○	○	○	○
Rinnakkaislääkevalmisteet	○	○	○	○	○
Lääkkeiden jakaminen potilaskohtaisiin annoksiin	○	○	○	○	○
Kiinteiden ja nestemäisten lääkkeiden annostus	○	○	○	○	○
Infuusionopeuden laskeminen	○	○	○	○	○
Liuoksen valmistaminen	○	○	○	○	○
Lääkkeiden antaminen eri lääkemuodoissa	○	○	○	○	○
Lääkkeiden antaminen eri antoreittejä	○	○	○	○	○

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Parenteraalisen nestehoidon perusteet	○	○	○	○	○
Parenteraalisen ravitsemuksen perusteet	○	○	○	○	○
Verensiirtohoidon perusteet	○	○	○	○	○
Lääkehoidon kirjaaminen ja tiedonkulun varmistaminen	○	○	○	○	○
Lääkkeiden terapeuttisten vaikutusten tunnistaminen	○	○	○	○	○
Lääkkeiden yhteis-, haitta- ja sivuvaikutusten tunnistaminen	○	○	○	○	○
Lääkehoidon ohjaus yleisellä tasolla	○	○	○	○	○
Lääkehoidon ohjaus eri potilasryhmillä	○	○	○	○	○
Lääkehoitoon sitoutumisen edistäminen ja tukeminen	○	○	○	○	○

3d. Lääkehoidon turvallisuuden edistäminen

	1 Ei sisälly lainkaan opetukseen	2 Painottuu vähän opetuksen toteutuksessa	3 Painottuu jonkin verran opetuksen toteutuksessa	4 Painottuu paljon opetuksen toteutuksessa	5 Painottuu erittäin paljon opetuksen toteutuksessa
Turvallisen lääkehoidon edistäminen sairaanhoitajan tehtävänä	○	○	○	○	○
Lääkehoitoon liittyvät haittatapahtumat ja niiden raportointi	○	○	○	○	○

Jotakin muuta, mitä

4. Arvioi tunteina yllämainittujen lääkehoidon perusteisiin liittyvien opetussisältöjen osuus omassa opetuksessasi

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Seuraavassa kysytään soveltavaan lääkehoitoon liittyvän opetuksen sisältöä ja painotusta opetuksen toteutuksessa asteikolla 1 ei sisälly lainkaan opetukseen - 5 painottuu erittäin paljon opetuksen toteutuksessa.

Soveltavalla lääkehoidon opetuksella tarkoitetaan lääkehoidon yleisten periaatteiden soveltamista sairauksia omaavien potilasryhmien lääkehoidon suunnittelussa, toteutuksessa ja arvioinnissa niin, että kyseisen potilasryhmän ja/tai lääkeryhmän erityispiirteet otetaan huomioon (esim. verenpainepotilaan lääkehoidon suunnittelu, toteutus ja arviointi).

5. Soveltavan lääkehoidon opetuksen sisältöalueet ja painotus vastuualueesi opetuksessa

5a. Sydän- ja verisuonisairauksien lääkehoito

	1 Ei sisälly lainkaan opetukseen	2 Painottuu vähän opetuksen toteutuksessa	3 Painottuu jonkin verran opetuksen toteutuksessa	4 Painottuu paljon opetuksen toteutuksessa	5 Painottuu erittäin paljon opetuksen toteutuksessa
Verenpainetauti	○	○	○	○	○
Sydämen vajaatoiminta	○	○	○	○	○
Sepelvaltimotauti	○	○	○	○	○
Rytmihäiriöt	○	○	○	○	○
Veren hyytymistä vähentävä tai hyytymiä liuottava lääkehoito	○	○	○	○	○

5b. Hengityselinten sairauksien lääkehoito

	1 Ei sisälly lainkaan opetukseen	2 Painottuu vähän opetuksen toteutuksessa	3 Painottuu jonkin verran opetuksen toteutuksessa	4 Painottuu paljon opetuksen toteutuksessa	5 Painottuu erittäin paljon opetuksen toteutuksessa
Tukkeuttavat keuhkosairaudet (astma, COPD)	○	○	○	○	○
Hengitystietulehdukset	○	○	○	○	○

5c. Ruuansulatuskanavan sairauksien lääkehoito

	1 Ei sisälly lainkaan opetukseen	2 Painottuu vähän opetuksen toteutuksessa	3 Painottuu jonkin verran opetuksen toteutuksessa	4 Painottuu paljon opetuksen toteutuksessa	5 Painottuu erittäin paljon opetuksen toteutuksessa
Ruokatorven, mahalaukun ja ohutsuolen sairaudet (mm. ulkustauti)	○	○	○	○	○
Krooniset tulehdukselliset suolistosairaudet (mm. Crohnin tauti, haavainen paksusuolen tulehdus)	○	○	○	○	○
Toiminnalliset sairaudet (mm. ripuli, ummetus pahoinvointi)	○	○	○	○	○
Maksan ja eksokriinisen haiman sairaudet	○	○	○	○	○
Munuaisten ja virtsateiden sairaudet	○	○	○	○	○

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5d. Endokriinisten ja metabolisten sairauksien lääkehoito

	1 Ei sisälly lainkaan opetukseen	2 Painottuu vähän opetuksen toteutuksessa	3 Painottuu jonkin verran opetuksen toteutuksessa	4 Painottuu paljon opetuksen toteutuksessa	5 Painottuu erittäin paljon opetuksen toteutuksessa
Diabetes	○	○	○	○	○
Rasva-aineenvaihdunnan häiriöt (mm. hyperkolesterolemia)	○	○	○	○	○
Kilpirauhasen sairaudet	○	○	○	○	○
Gynekologiset ja andrologiset lääkkeet	○	○	○	○	○

5e. Neurologisten sairauksien lääkehoito

	1 Ei sisälly lainkaan opetukseen	2 Painottuu vähän opetuksen toteutuksessa	3 Painottuu jonkin verran opetuksen toteutuksessa	4 Painottuu paljon opetuksen toteutuksessa	5 Painottuu erittäin paljon opetuksen toteutuksessa
Epilepsia	○	○	○	○	○
Parkinsonin tauti	○	○	○	○	○
Päänsärky	○	○	○	○	○
Muistihäiriöt (mm. Alzheimerin tauti)	○	○	○	○	○

5f. Psykiatristen sairauksien lääkehoito

	1 Ei sisälly lainkaan opetukseen	2 Painottuu vähän opetuksen toteutuksessa	3 Painottuu jonkin verran opetuksen toteutuksessa	4 Painottuu paljon opetuksen toteutuksessa	5 Painottuu erittäin paljon opetuksen toteutuksessa
Mielialahäiriöt	○	○	○	○	○
Psykoottiset tilat	○	○	○	○	○
Ahdistuneisuus	○	○	○	○	○
Unettomuus	○	○	○	○	○
Päihderiippuvuus	○	○	○	○	○

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5g. Muiden sairauksien lääkehoito, yksittäiset lääkeryhmät ja lääkkeet

	1 Ei sisälly lainkaan opetukseen	2 Painottuu vähän opetuksen toteutuksessa	3 Painottuu jonkin verran opetuksen toteutuksessa	4 Painottuu paljon opetuksen toteutuksessa	5 Painottuu erittäin paljon opetuksen toteutuksessa
Syöpäsairaudet	○	○	○	○	○
Tuki- ja liikuntaelinten sairaudet	○	○	○	○	○
Voimakkaat kipulääkkeet (mm. opioidit)	○	○	○	○	○
Anestesialääkkeet	○	○	○	○	○
Puudutteet	○	○	○	○	○
Tavalliset kipu- ja kuumelääkkeet (mm. parasetamoli ja ibuprofeeni)	○	○	○	○	○
Mikrobilääkkeet	○	○	○	○	○
Ihosairauksien lääkehoito	○	○	○	○	○
Korva-, nenä-, kurkku- ja silmäsairauksien lääkehoito	○	○	○	○	○
Elvytyslääkkeet	○	○	○	○	○
Anafylaktisen reaktion lääkehoito	○	○	○	○	○
Myrkytystilan lääkehoito	○	○	○	○	○
Rokotteet	○	○	○	○	○
Itsehoitovalmisteet (yhteisvaikutukset/ epäadekvaatti käyttö)	○	○	○	○	○

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Seuraavassa kysytään mielipidettäsi lääkehoidon opetukseen käytettävästä ajasta opetussuunnitelman toteuttamisessa. Vastaa valitsemalla omaa mielipidettäsi vastaava kohta. Voit antaa täydentäviä tietoja lisätietoja kohdassa.

7. Lääkehoidon opetuksen toteuttamiseen käytettävä aika opetussuunnitelmassa

	1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei eri eikä samaa mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä
Lääkehoidon perusteiden opetukseen on käytettävissä riittävästi aikaa opetussuunnitelman toteuttamisessa	○	○	○	○	○
Lääkehoidon soveltavaan opetukseen on käytettävissä riittävästi aikaa opetussuunnitelman toteuttamisessa	○	○	○	○	○
Lääkehoidon opetukseen käytettävissä oleva aika mahdollistaa hyvin asetettujen oppimistavoitteiden saavuttamisen vastuualueesi opetuksessa	○	○	○	○	○
Lääkehoidon opetus mahdollistaa sairaanhoitajaopiskelijan osaamisen kehittymisen riittävälle tasolle lääkehoidon turvallisen ja tehokkaan toteuttamisen näkökulmasta koulutuksen aikana	○	○	○	○	○

Jotakin muuta, mitä

6. Arvioi tunteina yllämainittujen soveltavan lääkehoidon opetussisältöjen osuus omassa opetuksessasi

Lisätietoja

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C) Lääkehoidon opetusmenetelmät

Seuraavassa kysytään opetusmenetelmiä, joita käytät lääkehoidon opetuksessa oman vastuualueesi opetuksessa

8. Mitä seuraavista opetusmenetelmistä käytetään lääkehoidon **lähiopetuksessa** vastuualueesi opetuksessa

- ☐ Luento-opetus
- ☐ Luokassa tapahtuva harjoittelu
- ☐ Simulaatioharjoitukset
- ☐ Seminaarityöskentely
- ☐ Tutoriaalityöskentely
- ☐ Opintokäynnit
- ☐ Henkilökohtainen ohjaus ja opetus ongelmatilanteissa
- ☐ muuta, mitä

9. Mitä seuraavista opetusmenetelmistä käytät lääkehoidon **ohjatussa/ itsenäisessä opiskelussa** vastuualueesi opetuksessa

- ☐ Ohjattu työskentely verkko-oppimisympäristössä
- ☐ Ohjattu työpajatyöskentely
- ☐ Itsenäinen työskentely verkko-oppimisympäristössä
- ☐ Itsenäinen työpajatyöskentely
- ☐ Kirjallisia yksilötehtäviä
- ☐ Kirjallisia ryhmätehtäviä
- ☐ muuta, mitä

10. Mikä on kaikkien yleisin käyttämäsi opetusmenetelmä lääkehoidon opetuksessa?

- --
- Luento-opetus
- Luokassa tapahtuva harjoittelu
- Simulaatioharjoitus
- Tutoriaali- tai seminaarityöskentely
- Opintokäynti
- Henkilökohtainen ohjaus ja opetus ongelmatilanteissa
- Ohjattu työskentely verkko-oppimisympäristössä
- Ohjattu työpajatyöskentely
- Kirjallinen yksilötehtävä
- Kirjallinen ryhmätehtävä

11. Mikä on toiseksi yleisin käyttämäsi opetusmenetelmä lääkehoidon opetuksessa?

- --
- Luento-opetus
- Luokassa tapahtuva harjoittelu
- Simulaatioharjoitus
- Tutoriaali- tai seminaarityöskentely
- Opintokäynti
- Henkilökohtainen ohjaus ja opetus ongelmatilanteissa
- Ohjattu työskentely verkko-oppimisympäristössä
- Ohjattu työpajatyöskentely
- Kirjallinen yksilötehtävä
- Kirjallinen ryhmätehtävä

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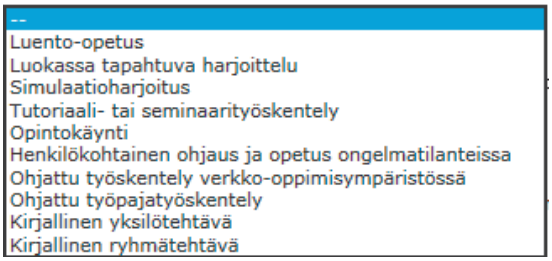
12. Mikä on kolmanneksi yleisin käyttämäsi opetusmenetelmä lääkehoidon opetuksessa?



13. Miten sairaanhoitajaopiskelijan lääkehoidon osaamista arvioidaan oman opetusalueesi opetuksessa?

- ☐ Kirjallisella kokeella
- ☐ Näyttö- tai taitokokeella
- ☐ Lääkelaskentakokeella
- ☐ Kirjallisella tehtävällä
- ☐ Jollain muulla, millä

Lisätietoja

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D) Lääkehoidon oppimisympäristö

Seuraavassa on lääkehoidon oppimisympäristöön ammattikorkeakoulun tiloissa liittyen kysymyksiä. Valitse ne vaihtoehdot, jotka vastaavat oman opetusalueesi toteutusta. Lopuksi kysytyään lääkehoidon opetuksessa käytettävää opetusmateriaalia ja sen kehittämistarpeita.

14. Mitä seuraavista lääkehoidon toteuttamisessa tarvittavista taidoista harjoitellaan ammattikorkeakoulun tiloissa oman opetusalueesi opetuksessa?

- ☐ Lääkkeiden säilytys
- ☐ Lääkkeiden tilaaminen
- ☐ Lääkehoitoon liittyvien tiedonlähteiden käyttö (mm. Pharmaca Fennica, peruslääkevalikoiman käyttö)
- ☐ Potilaan lääkehoidon suunnittelu (esim. nestehoidon toteutus)
- ☐ Lääkekorttien merkintä
- ☐ Lääkkeiden valmistuksessa käytettävien tarvikkeiden käyttö ja hävittäminen
- ☐ Lääkelaskenta
- ☐ Lääkkeen vetäminen injektioruiskuun
- ☐ Lääkkeen valmistaminen laimentamalla
- ☐ Lääkkeen lisääminen infuusionesteeseen
- ☐ Nesteensiirtoletkuston täyttäminen
- ☐ Lääkkeiden jakaminen potilaskohtaisiin annoksiin
- ☐ Lääkelusikan käyttäminen
- ☐ Lääkkeen puolittajan käyttäminen
- ☐ Lääkemurskaimen käyttäminen
- ☐ Lääkedosetin käyttäminen
- ☐ Insuliinikynän käyttäminen

- ☐ Spiran käyttäminen
- ☐ Inhalaattoriin liitettävän tilan jatkeen käyttäminen (esim. Volymatic®/ Babyhaler®)
- ☐ Kolmitiehanan käyttäminen
- ☐ Infuusiopumpun käyttäminen
- ☐ Perfuusorin (ruiskupumpun) käyttäminen
- ☐ PCA – pumpun (kipupumpun) käyttäminen
- ☐ Perifeerisen laskimon kanylointi
- ☐ Perifeerisen laskimokanyylin hoito
- ☐ Keskuslaskimokatetrin käyttö ja huolto
- ☐ Infuusioportin käyttö ja huolto
- ☐ Lääkkeen antaminen suun kautta
- ☐ Lääkkeen antaminen hengitysteihin
- ☐ Lääkkeiden antaminen nenämahaletkun tai PEG-letkun kautta
- ☐ Lääkkeen antaminen ihon kautta (esim. voiteet, laastarit)
- ☐ Lääkkeen antaminen silmään
- ☐ Lääkkeen antaminen nenään
- ☐ Lääkkeen antaminen korvaan
- ☐ Lääkkeen antaminen emättimen kautta
- ☐ Lääkkeen antaminen rektaalisesti
- ☐ Injektion antaminen lihakseen
- ☐ Injektion antaminen ihon alle
- ☐ Injektion antaminen ihon sisään
- ☐ Lääkeruiskeen antaminen boluksena laskimoon
- ☐ Lääkkeen antaminen epiduraalitilaan
- ☐ Verituotteiden antaminen
- ☐ Lääkkeellisen hapen antaminen
- ☐ Lääkehoidon dokumentointi
- ☐ Jokin muu, mikä

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15. Millaisia neste- ja lääkevalmisteita lääkehoidon opetuksessa käytetään (esimerkiksi lumelääkkeet ja - nesteet, isotoniset keittosuolavalmisteet, oikeat lääkevalmisteet) vastuualueesi opetuksessa?

16. Millaisia opetusvälineitä lääkehoidon opetuksessa käytetään (esimerkiksi lääkkeiden käyttökuntoon saattamiseen tarvittavat välineet, hoitoteknologia) vastuualueesi opetuksessa?

17. Millaisia kehittämistarpeita ammattikorkeakoulussasi on lääkehoidon opetuksessa käytettävän opetusvälineistön osalta?

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Appendix 2. Instrumentation of the study

INSTRUMENTS	Items	Response scales
EVALUATION OF CURRENT MEDICATION EDUCATION		
Medication Education Curriculum and Implementation [MECI], Managers of undergraduate nursing programmes*	Background factors of the polytechnic schools (6 items)	The number of units in the polytechnic school and nurse students: open Clinical practice placements: selection of practice placements and open Entrance examination: yes or no, open question for on the use of information gathered in entrance examination Division of teaching hours per ECST credit on contact and self-directed learning: open
	The structure and implementation of the curriculum (8 items)	Conception of learning in background of curriculum and implementation model of curriculum, open Implementation model of basic medication education and clinical pharmacology (integration), selection with open for additional information Teachers responsible of teaching basic medication education, medication calculations and clinical pharmacology: selection with open for additional information The amount of ECTS –credits devoted to medication education, open
	Satisfaction on current medication education (4 items)	Likert scale (1 strongly disagree – 5 strongly agree
	The methods of evaluating the learning outcomes of medication education (6 items)	Selection with open for additional information

INSTRUMENTS	Items	Response scales
Medication Education Implementation [MEI]), teachers**	Background information (2 items)	Job position, selection with open for additional information Area of teaching, open
	The content and amount of medication education in own are of teaching[sc]: Professional basis of medication management and administration (6 items) Theoretical foundation of medication management and administration (17 items) Administration of medication in different phases of the medication process (21 items) Promotion of medication safety (2 items)	1= not included in own teaching area, 2 weak 5 very strong emphasis in teaching
	The amount of medication education in own teaching area	open
	Satisfaction on current medication education (4 items)	Likert scale (1 strongly disagree – 5 strongly agree
	Teaching methods used in medication education (6 items)	Selection with open for additional information
	Practice possibilities on different tasks and equipment used in medication management in school facilities	Selection with open for additional information
	Teaching materials used in medication education and need for development	open

Instruments	Items	Respone scales
EVALUTION OF MEDICATION COMPTENCE AND ASSOCIATED FACTORS*		
Individual factors		
MCAF	Sosio-demographic factors (12 items) Age Gender Semester (2nd, 7th semester) Previous education (upper secondary school/diploma degree in nursing) Previous success in studies (previous grades, passing medication calculation test, participation on supportive education) Working experience in health care prior to nursing studies Working experience as RN substitute during the nursing studies (only 7th semester students) Number of clinical practice placements The use of Medication Passport Students perceptions on the method used in medication calculations and verifying of the results (3 items)	 open selection selection selection selection open open open selection selection of methods scale 1 *Never*-3 *Always*
ILS (Vermunt 1998)	Learning style (13 items) Self-Regulation[sc] External-Regulation [sc] Lack of regulation[sc]	Likert scale 1 *seldom* – 5 *never*
MCAF	Students perceptions on their activeness in participating medication education[sc] (4 items)	Likert scale 1 *strongly disagree* – 5 *strongly agree*)

Instruments	Items	Scales
MCAF	Students perceptions on their self-confidence on medication administration[sc] (6 items)	Likert scale 1 *strongly disagree* – 5 *strongly agree*
MCAF	Students perceptions on their motivation on studying medication care (1 item)	Likert scale 1 *strongly disagree* – 5 *strongly agree*
MCAF	Students satisfaction on current amount of medication education (1 item)	Likert scale1 *strongly disagree* – 5 *strongly agree*
MCS (Grandell-Niemi 2005)	Students perceptions on mathematics, medication calculation and pharmacology being easy (3 items)	Likert scale 1 *strongly disagree* – 5 *strongly agree*
Factors related to clinical learning environment and educational institution		
MCAF Clinical learning environment	Students perceptions on learning medication administration in clinical learning practice placement (7th semester students) [sc] (14 items)	Likert scale 1 *strongly disagree* – 5 *strongly agree*)
Education institute	Students perceptions on practicing tasks related to medication administration in clinical practice placement and polytechnic schools , only 7th semester students (26 items)	selection
Evaluation of medication competence		
MCAF 16 items, MCS 11 items (Grandell-Niemi 2005),MNS 3 modified items (Veräjänkorva 2003)	Theoretical medication competence (Knowledge test, 30 items) [sc]	Dichotomy scale with Right, Wrong, I don't know choices
MCAF 4 items, MCS 6 modified items (Grandell-Niemi 2005)	Practical medication competence (Medication calculation test, 10 items) [sc]	4 multiple choices and I don't know choice
MCAF	Decision making competence (Patient vignettes, 10 items) [sc]	3 multiple choices for action in given situation and I don't know choice

sc = Sum-scores formed, * appendix 1, ** appendix 2, *** appendix 3, MCAF questionnaire is not published as appendix to ensure validity of the instrument in future studies and to avoid re- publishing of previously developed instruments

Appendix 3. Practice placement possibilities of nursing students

Organisation	**Possibility to practice (fr)**
University hospital	20
Central/Regional hospital	22
Health care centre	22
Primary care units	22
Social wellfare units	17
Private social and health care units	22
Clinic at the school	15
somewhere else	In International Exchange (n=6) Participating research and development projects (n=1) in Trusts (n=1)

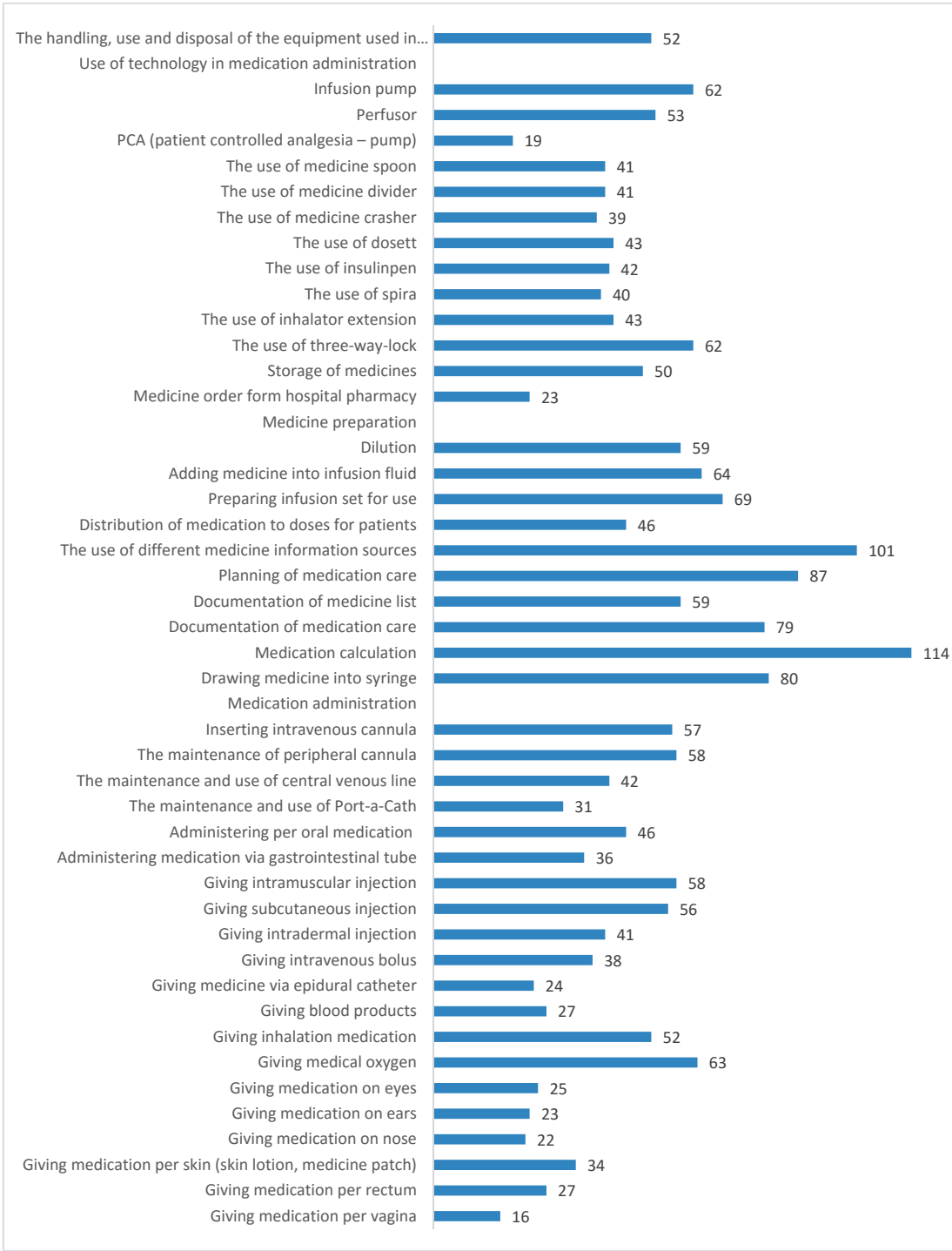
Appendix 4. Descriptive statistics of the content of medication education

Question	n[1)]	Mean[2)]	SD	Range
Q3a_1	113	2,31	1,111	1-4
Q3a_2	121	2,41	1,070	1-4
Q3a_3	123	2,77	0,965	1-4
Q3a_4	126	2,55	0,993	1-4
Q3a_5	128	3,23	,932	1-4
Q3a_6	126	2,67	1,020	1-4
Q3b_1	117	2,46	1,030	1-4
Q3b_2	124	2,57	0,989	1-4
Q3b_3	124	3,13	0,987	1-4
Q3b_4	80	1,46	0,711	1-4
Q3b_5	103	2,21	1,026	1-4
Q3b_6	123	2,97	1,063	1-4
Q3b_7	110	2,26	1,106	1-4
Q3b_8	110	2,36	1,187	1-4
Q3b_9	94	2,38	1,079	1-4
Q3b_10	94	2,34	1,093	1-4
Q3b_11	90	1,78	0,957	1-4
Q3b_12	116	2,88	1,173	1-4
Q3b_13	97	2,03	1,084	1-4
Q3b_14	106	2,18	1,022	1-4
Q3b_15	95	1,91	0,912	1-4
Q3b_16	94	1,77	0,885	1-4
Q3b_17	86	1,92	1,008	1-4
Q3c_1	82	2,11	1,066	1-4
Q3c_2	108	2,21	1,059	1-4
Q3c_3	105	2,31	1,086	1-4
Q3c_4	109	2,85	1,035	1-4
Q3c_5	119	2,71	1,067	1-4
Q3c_6	108	2,19	1,089	1-4
Q3c_7	106	2,66	1,154	1-4
Q3c_8	112	2,74	1,113	1-4
Q3c_9	106	2,98	1,023	1-4
Q3c_10	104	2,80	1,144	1-4
Q3c_11	118	2,92	1,071	1-4
Q3c_12	120	2,93	1,078	1-4
Q3c_13	100	2,69	1,161	1-4
Q3c_14	85	2,55	1,075	1-4
Q3c_15	77	2,51	1,188	1-4
Q3c_16	123	2,94	1,002	1-4
Q3c_17	123	2,64	1,025	1-4
Q3c_18	126	2,66	0,989	1-4
Q3c_19	124	2,69	0,997	1-4
Q3c_20	114	2,28	1,009	1-4
Q3c_21	123	2,50	1,097	1-4
Q3d_1	126	3,25	0,876	1-4
Q3a_2	125	2,73	1,042	1-4

Question	n[1)]	Mean[2)]	SD	Range
Q5a_1	90	2,37	1,136	1-4
Q5a_2	89	2,34	1,097	1-4
Q5a_3	86	2,49	1,155	1-4
Q5a_4	87	2,18	1,040	1-4
Q5a_5	87	2,72	1,019	1-4
Q5b_1	98	2,43	1,103	1-4
Q5b_2	94	2,18	1,026	1-4
Q5c_1	78	1,99	0,904	1-4
Q5c_2	70	1,83	0834	1-4
Q5c_3	93	2,26	0,977	1-4
Q5c_4	75	1,84	1,001	1-4
Q5c_5	89	2,09	1,051	1-4
Q5c_6				1-4
Q5d_1	102	2,63	1,168	1-4
Q5d_2	77	2,23	1,099	1-4
Q5d_4	73	1,73	0,870	1-4
Q5d_4	52	1,83	1,043	1-4
Q5e_1	87	2,01	0,994	1-4
Q5e_2	66	2,00	0,992	1-4
Q5e_3	80	1,90	0,976	1-4
Q5e_4	72	1,97	1,007	1-4
Q5f_1	61	2,46	1,058	1-4
Q5f_2	57	2,42	1,085	1-4
Q5f_3	62	2,31	1,095	1-4
Q5f_4	78	2,27	1,053	1-4
Q5f_5	78	2,04	1,038	1-4
Q5g_1	87	2,16	0,987	1-4
Q5g_2	76	2,01	0,887	1-4
Q5g_3	116	2,74	1,005	1-4
Q5g_4	81	2,35	1,164	1-4
Q5g_5	90	2,30	1,156	1-4
Q5g_6	119	2,72	1,008	1-4
Q5g_7	110	2,44	1,009	1-4
Q5g_8	66	1,71	0,873	1-4
Q5g_9	68	1,56	0,799	1-4
Q5g_10	95	2,69	1,168	1-4
Q5g_11	106	2,74	1,141	1-4
Q5g_12	81	2,35	1,153	1-4
Q5g_13	58	2,09	1,144	1-4
Q5g_14	86	1,91	1,047	1-4

[1)]Responses “topic not included own teaching” were excluded, [s 2)] Scale 1=little emphasis, 2=some, 3=strong and 4=very strong emphasis. SD= Standard deviation

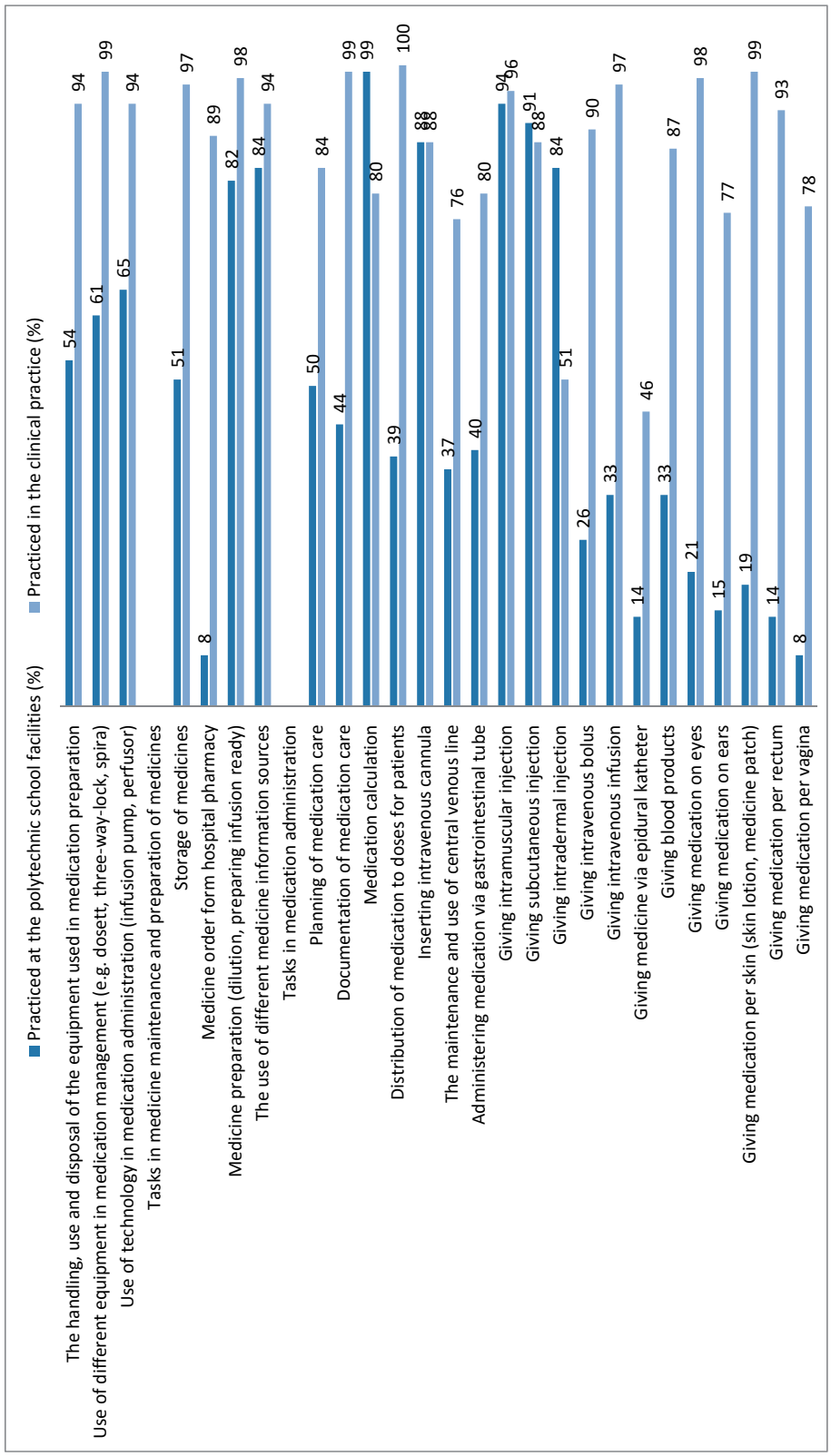
Appendix 5. Tasks and equipment related to medication management possible to practice at the school



Appendix 6. 7th semester students' perceptions of learning medication management in clinical learning environment

7th semester students (n=338) **perceptions of learning medication management in clinical practice** (scale 1 strongly disagree – 5 strongly agree)	**Mean (SD)**	**MD (range)**
I have been orientated to responsibilities and tasks on medication management in the beginning of clinical practice	3.39 (0.96)	4.00
I have had enough possibilities to practice tasks in medication care in clinical practice	3.45 (1.05)	4.00
I have been able to apply my knowledge on medication care in clinical practice	3.92 (0.68)	4.00
I have been expected to have better medication competence than I have in clinical practice	2.49 (0.97)	2.00
SUM-score practice placement	**3.58 (0.62)**	**3.5 (1-5)**
I have delivered too many tasks in medication care without adequate supervision	2.14 (0.85)	2.00
I am satisfied with the supervision I have received when delivering tasks on medication care	3.62 (0.82)	4.00
Nurse mentors have had an important role in my learning medication care	4.13 (0.76)	4.00
Good supervision relationship with the mentor has enhanced my learning medication care in clinical practice	4.28 (0.66)	4.00
Nurse mentors have had a positive attitude towards my supervision in medication care	3.95 (0.72)	4.00
I have received feedback from nurse mentors on my medication competence development	3.77 (0.88)	4.00
Sum-score supervision	**3.93 (0.50)**	**4.00 (2-5)**
Nurse teachers supervising the clinical practice have supported me in setting learning goals in medication care	3.01 (1.03)	3.00
Nurse teachers supervising the clinical practice have supported me in integrating theory and practice in medication care	2.87 (0.99)	3.00
Medication education at the school and the medication care in clinical practice have corresponded well	2.98 (0.98)	3.00
SUM-score teacher	**2.95 (0.81)**	**3.00**
Single item		
The use of Medication Passport has supported my learning of medication care in clinical practice	2.48 (1.09)	2.00

Appendix 7. Tasks and equipment related to medication management practiced at school facilities and/or clinical practice placements (7th semester students, n= 338)



Appendix 8. The proportion of wrong, I don't know and missing answers in medication competence evaluation

Question	Correct answer n (%)	Wrong answer n (%)	I don't know n (%)			Missing n (%)
			2nd semester	7th semester	both groups	
Theoretical medication competence (topic of the question)						
Q62 (generic name)	254(38,1)	239(35,9)	**78(23,9)**	**88(26,4)**	**166(24,9)**	**7(1,1)**
Q63 (therapeutic equivalent product**)**	651(97,7)	12(1,8)	0	1(0,3)	1(0,2)	2(0,3)
Q64 (generic substitution)	420(63,1)	60(9)	**97(29,8)**	**84(16,1)**	**181(27,2)**	5(0,8)
Q65 (Supervision authority of pharmacotherapeutics**)**	158(23,7)	**305(45,8)**	**96(29,3)**	**99(29,9)**	**195(29,3)**	8(1,2)
Q66 (validity of medicine prescription)	559(83,9)	52(7,8)	30(9,2)	23(6,9)	53(8)	2(0,3)
Q67* (meaning of order 1 x 4)	538(80,8)	122(18,3)	0	2(0,6)	2(0,3)	4(0,6)
Q68* (meaning of abbreviation PKV)	215(32,3)	226(33,9)	**85(26)**	**134(40,2)**	**219(32,9)**	**6(0,9)**
Q69* (meaning of abbreviation of s.c)	612(91,9)	48(7,2)	2(0,6)	0	2(0,3)	4(0,6)
Q70* (meaning of red triangle)	655((98,3)	4(0,6)	6(1,8)	0	6(0,9)	1(0,2)
Q71 (meaning of bolus inj.)	497(74,6)	63(9,5)	97(29,7)	4(1,2)	101(15,2)	5(0,8)
Q72* (meaning of tolerance)	575(86,3)	34(5,1)	43(13,1)	12(3,6)	55(8,3)	2(0,3)
Q73* (meaning of interaction)	48(7,2)	**518(77,8)**	72(22)	24(7,2)	96(14,4)	4(0,6)
Q74** (meaning of steady state**)**	276(41,4)	126(18,9)	**130(40)**	**126(37,8)**	**256(38,4)**	**8(1,2)**
Q75 (absorption of water soluble **medicine)**	169(25,4)	**355(53,3)**	49(15)	86(25,8)	135(20,3)	7(1,1)
Q76 (drug elimination route)	507(76,1)	97(14,6)	26(8)	30(9)	56(8,4)	6(0,9)
Q77* (patient age and drug metabolism**)**	607(91,1)	17(2,6)	31(9,5)	7(2)	38(5,7)	4(0,6)
Q78 (absorption and drug form)	629(94,4)	11(1,7)	12(3,7)	11(3,3)	23(3,5)	3(0,5)
Q79* (absorption from depot drug)	526(79)	96(14,4)	23(7)	17(5)	40(6)	4(0,6)
Q80* (drug effect and receptors)	434(65,2)	33(5)	**77(23,5)**	**116(34,8)**	**193(29)**	**6(0,9)**
Q81* (function of antagonist)	177(26,6)	**250(37,5)**	**105(32,3)**	**126(37,8)**	**231(34,7)**	**8(1,2)**
Q82 (storage of insulin)	503(75,5)	106(15,9)	43(13)	13(3,9)	56(8,4)	1(0,2)
Q83* (administering of resoriblett)	465(69,8)	66(9,9)	68(20,8)	62(18,6)	130(19,5)	5(0,8)
Q84 (Crushing of depot tablet)	619(92,9)	12(1,8)	19(5,8)	14(4,2)	33(5,0)	2(0,3)

Q85** (crushing of drugs)	578(86,8)	47(7,1)	25(7,6)	13(3,7)	38(5,7)	3(0,5)
Q86 (administering infusionconcentrat)	529(79,4)	37(5,6)	66(20,3)	27(8)	93(14)	7(1,1)
Q87 (drug forms suitable for iv-route)	583(87,5)	18(2,7)	45(13,8)	16(4,8)	61(9,2)	4(0,6)
Q88** (Z-technique)	597(89,6)	38(5,7)	12(3,7)	16(4,7)	28(4,2)	3(0,5)
Q89 (drug administration route and effect)	511(76,7)	87(3,1)	32(9,8)	34(10)	66(9,9)	2(0,3)
Q90 (administration of entero products)	247(37,1)	207(31,1)	**101(31)**	**105(31,3)**	**206(30,9)**	**6(0,9)**
Q91 (patient has forgotten medicine, administering the next dose)	654(98,2)	3(0,5)	6(1,8)	2(0,6)	8(1,2)	1(0,2)

* item from MCS (Grandell-Niemi 2005), ** modified item from MNS (Veräjänkorva 2003)

Practical medication competence (types of questions in paper IV)

Question	**Correct answer n (%)**	**Wrong answer n (%)**	**I don't know n (%)**			**Missing n (%)**
			2nd semester	**7th semester**	**both groups**	
Q92*	643(96,5)	6(1)	5(1,5)	4(1,2)	9(1,4)	8(1,2)
Q93	212(31,8)	290(43,6)	**77(23,7)**	**65(20,4)**	**132(31,8)**	**22(3,3)**
Q94	477(71,6)	73(11,1)	52(16)	43(13,4)	95(14,3)	21(3,2)
Q95	597(89,6)	20(3,1)	23(7,1)	13(4)	36(5,4)	13(2)
Q96*	585(87,8)	32(4,9)	22(6,8)	16(4,9)	38(5,7)	11(1,7)
Q97	537(80,6)	71(10,7)	27(8,3)	18(5,5)	45(6,8)	13(2,0)
Q98	520(78,1)	81(12,2)	25(7,7)	26(8)	51(7,7)	14(2,1)
Q99	458(68,8)	159(23,9)	20(6,2)	14(4,3)	34(5,1)	15(2,3)
Q100	547(82,1)	43(6,6)	**31(9,7)**	**25(7,7)**	**56(8,4)**	**20(3)**
Q101	356(53,5)	74(11,6)	**98(30,3)**	**110(34,9)**	**208(31,2)**	**28(4,2)**

* item modified from MCS (Grandell-Niemi 2005)

Decision- making competence (types of questions in paper IV)						
Question	**Correct answer n (%)**	**Wrong answer n (%)**	**I don't know n (%)**			**Missing n (%)**
			2nd semester	**7th semester**	**both groups**	
Q102	499(74,9)	44(6,6)	63(19,6)	40(12,3)	103(15,5)	20(3)
Q103	458(68,8) / 32(4,8)	44 (6,6)	88(27,2)	26(8)	114(17,1)	18(2,7)
Q104	363(54,5)	110(16,5)	**113(35)**	62(19,1)	175(26,3)	18(2,7)
Q105	312(46,8)	172(25,9)	**110(34)**	52(16)	162(24,3)	20(3)
Q106	345(51,8)/ 77(11,6)	189(28,4)	26(8,1)	8(2,5)	34(5,1)	21(3,2)
Q107	84(12,6)/ 310 (46,5)	111(16,7)	**102(31,7)**	37(11,5)	139(20,9)	22(3,3)
Q108	330 (49,5)	244(36,6)	51(15,8)	19(5.9)	70(10,5)	22(3,3)
Q109	426 (64)/ 82(12,3)	22(3,3)	**83(25,8)**	29(9)	112(6,8)	24(3,6)
Q110	527(79,1)	31(4,7)	59(18)	24((7,5)	83(12,5)	25(3,8)
Q111	302(45,3)	154(23,1)	**139(43)**	50(15,5)	189(28,4)	21(3,2)

Appendix 9. Univariate individual factors associated with students' medication competence areas (% correct answers)

			Theoretical medication competence	Practical medication competence	Decision-making competence
Individual factors					
Associated factor [1)]		**n**	**mean (SD)**	**mean (SD)**	**mean (SD)**
Age			***	*	**
	19-20 years	95	68.6 (14.1)	67.7 (26.4)	49.8 (21.8)
	21-25 years	370	71.4 (12.1)	75.0 (22.9)	58.0 (20.0)
	26-30 years	98	74.0 (10.0)	76.0 (21.6)	58.3 (22.5)
	31- years	84	75.0 (9.6)	77.7 (19.9)	57.5 (16.8)
Gender			*	ns	ns
	Female	592	71.5 (11.9)	-	-
	Male	70	74.9 (12.1)	-	-
Previous degree in nursing			ns	*	*
	Licensed nurse	142	-	70.6 (22.3)	59.8 (18.2)
	No	521	-	75.4 (23.2)	55.7 (20.9)
Matriculation exam in mathematics			*	***	ns
	Long syllabus	129	74.0 (11.5)	84.0 (19.6)	-
	Short syllabus	276	70.4 (12.6)	73.4 (22.4)	-
	No matriculation exam in mathematics	245	72.5 (11.3)	70.6 (24.0)	-
Long syllabus in mathematics			*	***	ns
	Yes	129	74.0 (11.5)	84.0 (19.6)	-
	No	521	71.4 (12.1)	72.1 (23.2)	-
Failed medication calculation test			*	*	ns
	Yes	425	71.1 (11.4)	72.8 (22.4)	-
	No	237	73.3 (12.7)	77.3 (23.9)	-
Participation in supportive medication in calculation education			***	***	ns
	Yes	131	68.2 (11.9)	64.2 (25.7)	-
	No	529	72.7 (11.8)	76.9 (21.7)	-
Failed theoretical exam on basics of medication management			*	ns	ns
	Yes	119	70.1 (11.3)	-	-
	No	534	72.5 (11.9)	-	-

		Theoretical medication competence	Practical medication competence	Decision-making competence
Individual factors				
Perceives pharmacology as easy				
Disagrees	274	71.8 (11.4)	-	57.4 (19.2)
Not disagree, not agree	273	70.3 (12.6)	-	53.7 (22.1)
Agrees	116	75.9 (10.7)	-	61.4 (18.1)
Satisfied with the amount of current education		ns	*	*
Disagrees	350	-	76.9 (20.6)	58.7 (19.9)
Not disagree, not agree	124	-	71.6 (26.0)	54.7 (21.6)
Agrees	187	-	71.7 (24.6)	54.0 (20.2)
Associated factor [2)]	**n**	**r**	**r**	**r**
Ability of self-regulated learning	665	0.15***	ns	ns
Lack of regulation in learning	664	-0.20***	-0.12**	-0.11**
Perceives mathematics as easy	665	0.18***	0.26***	ns
Grade in mathematics	662	0.17***	0.24***	ns
Grade in exam on theoretical basis of medication management	623	0.17***	0.15***	ns
Motivation in studying medication care	663	0.19***	0.08*	ns
Active participation in studying medication care	665	0.19***	ns	ns
Self-confidence in medication management	665	0.19***	ns	0.14***

Statistical tests: [1)] *t*-test, one-way ANOVA, [2)] Pearson correlation

	difference between categories / significance of r,
*	p<0.05
	difference between categories / significance of r,
**	p<0.01
	difference between categories / significance of r,
***	p<0.001
Ns,	
SD	not significant, SD=Standard devision

Appendix 10. Univariate environmental factors associated with students' medication competence areas (% correct answers)

			Theoretical medication competence	Practical medication competence	Decision making competence
Environmental factors					
Associated factor [1)]		**n**	**mean (SD)**	**mean (SD)**	**mean (SD)**
Semester			ns	ns	***
	2nd	327	-	-	51.1 (21.6)
	7th	338	-	-	62.2 (17.6)
Possibility to practise medication calculations in clinical practice (only 7th semester)			ns	*	ns
	Yes	269	-	77.1 (21.5)	-
	No	67	-	69.9 (23.2)	-
The Medication Passport in use [3)]			*	ns	ns
	Yes	610	72.1 (12.1)	-	-
	No	52	68.3 (10.1)	-	-
The use of a calculator			ns	***	ns
	Yes	126	-	86.6 (14.3)	-
	No	532	-	71.9 (23.4)	-
Associated factor [2)]		n	r	r	r
The number of clinical practice placements		622	ns	ns	0.25***
Perceives the Medication Passport as useful (only 7th semester)[1)]		331	0.17**	ns	ns

Statistical tests: [1)] *t*-test, one-way ANOVA, [2)] Pearson correlation

* difference between categories / significance of r, p<0.05

** difference between categories / significance of r, p<0.01

*** difference between categories / significance of r, p<0.001

Ns, SD not significant, SD=Standard deviation

Appendix 11. Differences between the schools (UAS) in medication competence of nursing students (% of correct answers)

Semester	UAS*	n	Theoretical medication competence (SD)	Practical medication competence (SD)	Decision making competence (SD)
2nd	1	81	68.68 (12.19)	86.54 (14.42)	50.38 (20.35)
	2	63	76.35 (10.82)	77.94 (21.49)	59.84 (21.72)
	3	42	69.29 (13.94)	71.43 (20.67)	51.22 (19.39)
	4	55	58.85 (15.29)	49.09 (26.96)	35.47 (21.62)
p			<.0001	<.0001	<.0001
7th	1	60	70.11 (10.96)	82.67 (18.94)	61.61 (18.56)
	2	46	74.78 (6.19)	74.57 (22.77)	62.93 (18.87)
	3	86	71.09 (10.26)	64.35 (24.17)	58.63 (17.91)
	4	52	73.14 (8.52)	80.38 (13.13)	66.08 (14.84)
p			0.143	<.0001	0.173

SD= Standard deviation, UAS=university of applied science previously polytechnic school, Variance analysis: Tukey-Kramer test. Only polytechnic schools with minimum amount of 40 students were compared.*Schools were not identified by the number.

Appendix 12. The independent determinants of 2nd and 7th semester students' medication competence areas

Appendix 12A. The independent determinants of 2nd semester students' theoretical medication competence (knowledge test, % of correct answers) (n=313)

Determinant		n	Adjusted mean (SE) [1]	β (SE)	p [2]
Age, years					0.03
	19-20	95	65.7 (2.36)	-4.9 (2.26)	
	21-25	126	66.7 (2.29)	-3.8 (2.11)	
	26-30	41	71.4 (2.75)	0.8 (2.64)	
	31-	51	70.6 (2.55)	0	
Previous nursing education					0.003
	Diploma degree	67	71.4 (2.32)	5.6 (1.85)	
	No diploma degree	246	65.8 (2.24)	0	
The Medication Passport in use					0.03
	Yes	303	73.1 (1.16)	9.1 (4.16)	
	No	10	64.0 (4.00)	0	
Participated in supportive medication calculation education					0.007
	No	253	71.3 (2.18)	5.3 (1.95)	
	Yes	60	65.9 (2.42)	0	
Perception of pharmacology as easy [3]					0.003
	Agree	54	71.2 (2.67)	1.9 (2.13)	
	Not agree, not disagree	140	65.2 (2.12)	-4.2 (1.59)	
	Disagree	119	69.4 (2.27)	0	
Self-regulation		313	-	1.9 (0.92)	0.04
Perception of mathematics and medication calculations as easy		313	-	2.7 (0.78)	0.0006
Lack of regulation		313	-	-2.9 (1.12)	0.01

Model 100 *R-square = 22.0%

Model F(11, 301)=7.72, p<0.0001

SE: standard error of estimate

1) The adjusted mean is the mean value of the category adjusted for all other determinants in the model.
2) Significance of the determinant.
3) In pair-wise comparisons, the following significant differences between categories were found: "Agree" and "Not agree, not disagree" (p=0.009), "Disagree" and "Not agree, not disagree" (p=0.02).

Appendix 12B. The independent determinants of 7th semester student's theoretical medication competence (knowledge test, % of correct answers) (n=328)

Determinant	n	Adjusted mean (SE) [1)]	β (SE)	p [2)]
The Medication Passport in use				0.04
Yes	292	73.2 (0.55)	3.5 (1.67)	
No	36	69.7 (1.58)	0	
Motivation	328	-	3.4 (0.67)	<0.0001
Perceives the Medication Passport as useful	328	-	1.2 (0.48)	0.01

Model 100 *R-square = 10.6%

Model F(3, 324)=12.83, p<0.0001

SE: standard error of estimate

1) The adjusted mean is the mean value of the category adjusted for all other determinants in the model.
2) Significance of the determinant.

Appendix 12C. The independent determinants of 2nd semester students' practical medication competence (medication calculation test, % of correct answers) (n=281)

Determinant		n	Adjusted mean (SE) [1)]	β (SE)	p [2)]
Age, years [3)]					0.01
	19-20	84	73.2 (2.64)	-8.4 (4.09)	
	21-25	121	81.3 (2.24)	-0.4 (3.93)	
	26-30	34	84.7 (3.93)	3.0 (4.91)	
	31-	42	81.7 (3.61)	0	
Long syllabus in matriculation examination in mathematics					0.02
	Yes	64	84.1 (3.03)	7.8 (3.23)	
	No	217	76.3 (1.93)	0	
Perception of pharmacology as easy [3)]					0.001
	Agree	52	76.5 (3.24)	-10.5 (3.74)	
	Not agree, not disagree	123	77.2 (2.45)	-9.8 (2.83)	
	Disagree	106	87.0 (2.57)	0	
Use of calculator					<0.0001
	Yes	60	87.0 (3.08)	13.6 (3.25)	
	No	221	73.4 (1.87)	0	
The number of clinical practice placements		281	-	-6.5 (1.86)	0.0005
Grade in mathematics		281	-	4.2 (1.69)	0.01
Grade in exam on theoretical basis of medication management		281	-	3.1 (1.22)	0.01
Perception of mathematics and medication calculations as easy		281	-	6.3 (1.66)	0.0002
Self-confidence				-5.9 (2.60)	0.02

Model 100 *R-square = 32.1%

Model F(12, 268)=10.55, p<0.0001

SE: standard error of estimate

1) The adjusted mean is the mean value of the category adjusted for all other determinants in the model.
2) Significance of the determinant.
3) In pair-wise comparisons, the following significant differences between the categories were found: "19-20 y" and "21-25 y" (p=0.04), "19-20 y" and "26-30 y" (p=0.04).
4) In pair-wise comparisons, the following significant differences between the categories were found: "Agree" and "Disagree" (p=0.02), "Not agree, not disagree" and "Disagree" (p=0.002).

Appendix 12D. The independent determinants of 7th semester students' practical medication competence (medication calculation test, % of correct answers) (n=323)

Determinant	n	Adjusted mean (SE) [1)]	β (SE)	p [2)]
Previous nursing education				0.05
Diploma degree	68	72.8 (3.39)	-5.5 (2.74)	
No diploma degree	255	78.3 (2.31)	0	
Long syllabus in matriculation examination in mathematics				0.002
Yes	59	80.3 (3.57)	9.5 (2.95)	
No	264	70.8 (2.16)	0	
Participated in supportive medication calculation education				0.002
No	261	80.2 (2.30)	9.3 (2.93)	
Yes	62	70.9 (3.47)	0	
Satisfied with the amount of current medication education [3)]				0.02
Agree	68	77.9 (3.32)	-0.4 (2.74)	
Not agree, not disagree	56	70.3 (3.37)	-8.0 (3.00)	
Disagree	199	78.3 (2.61)	0	
Possibility to apply theory in clinical practice				0.02
Yes	259	78.9 (2.46)	6.7 (2.73)	
No	64	72.2 (3.28)	0	
Use of calculator				<0.0001
Yes	54	82.1 (3.42)	13.1 (2.92)	
No	269	68.9 (2.36)	0	
Grade in mathematics	323	-	3.6 (1.44)	0.01

Model 100 *R-square = 19.8%

Model F(8, 314)=9.67, p<0.0001

SE: standard error of estimate

1) The adjusted mean is the mean value of the category adjusted for all other determinants in the model.
2) Significance of the determinant.
3) In pair-wise comparisons, the following significant differences between the categories were found: "Not agree, not disagree" and "Disagree" (p=0.02).

Appendix 12E. The independent determinants of 2nd semester students' decision-making competence (patient vignettes, % of correct answers) (n=313)

Determinant		n	Adjusted mean (SE) [1)]	β (SE)	p [2)]
Previous nursing education					0.007
	Diploma degree	67	58.7 (2.63)	7.9 (2.91)	
	No diploma degree	246	50.8 (1.43)	0	
Perception of pharmacology as easy [3)]					0.004
	Agree	55	59.6 (2.97)	4.2 (3.45)	
	Not agree, not disagree	141	49.3 (1.96)	-6.2 (2.64)	
	Disagree	117	55.4 (2.11)	0	

Model 100 *R-square = 5.7%

Model F(3, 309)=6.19, p=0.0004

SE: standard error of estimate

1) The adjusted mean is the mean value of the category adjusted for all other determinants in the model.
2) Significance of the determinant.
3) In pair-wise comparisons, the following significant differences between categories were found: "Agree" and "Not agree, not disagree" (p=0.006).

Appendix 12F. The independent determinants of 7th semester students' decision-making competence (patient vignettes, % of correct answers) (n=312)

Determinant	n	Adjusted mean (SE) [1)]	β (SE)	p [2)]
Lack of regulation	312	-	-3.3 (1.28)	0.01

Model 100 *R-square = 2.1%

Model F(1, 310)=6.73, p=0.01

SE: standard error of estimate

1) The adjusted mean is the mean value of the category adjusted for all other determinants in the model.
2) Significance of the determinant.

Appendix 13. The independent determinants of theoretical medication competence (knowledge test, % of correct answers) (n=638)

Determinant	n	Adjusted mean (SE) [1)]	β (SE)	p [2)]
Age, years [3)]				0.007
19-20	94	66.9 (1.45)	-5.4 (1.74)	
21-25	367	69.1 (0.99)	-3.2 (1.42)	
26-30	96	71.2 (1.37)	-1.1 (1.71)	
31-	81	72.3 (1.45)	0	
The Medication Passport in use				0.004
Yes	587	72.3 (0.68)	4.8 (1.64)	
No	51	67.5 (1.63)	0	
Participated in supportive medication calculation education				0.02
No	511	71.2 (0.93)	2.7 (1.16)	
Yes	127	68.5 (1.26)	0	
Perception of pharmacology as easy [4)]				0.002
Agree	109	71.6 (1.37)	1.3 (1.32)	
Not agree, not disagree	264	67.7 (1.05)	-2.7 (1.01)	
Disagree	265	70.3 (1.07)	0	
Grade in mathematics	638	-	1.4 (0.69)	0.01
Self-regulation	638	-	1.5 (0.57)	0.008
Lack of regulation	638	-	-1.7 (0.66)	0.01
Self-confidence	638	-	2.3 (0.83)	0.005
Motivation	638	-	1.4 (0.61)	0.02

Model 100 *R-square = 15.4%

Model F(12, 625)=9.52, p<0.0001

SE: standard error of estimate

4) The adjusted mean is the mean value of the category adjusted for all other determinants in the model.
5) Significance of the determinant.
6) In pair-wise comparisons, the following significant differences between categories were found: “19-20 y” and ”26-30 y” (p=0.04), “19-20 y” and “31- y” (p=0.01).
7) In pair-wise comparisons, the following significant differences between categories were found: “Agree” and ”Not agree, not disagree” (p=0.006), “Disagree” and “Not agree, not disagree” (p=0.02).

Appendix 14. The independent determinants of practical medication competence (medication calculation test, % of correct answers) (n=622)

Determinant	n	Adjusted mean (SE) [1)]	β (SE)	p [2)]
Age, years [3)]				0.0007
19-20	91	72.2 (2.44)	-12.7 (3.18)	
21-25	364	79.6 (1.66)	-5.2 (2.58)	
26-30	90	80.9 (2.62)	-3.9 (3.19)	
31-	77	84.8 (2.67)	0	
Long syllabus in matriculation examination in mathematics				<0.0001
Yes	125	83.8 (2.36)	8.8 (2.21)	
No	497	75.0 (1.49)	0	
Participated in supportive medication calculation education				0.02
No	505	82.1 (1.47)	5.3 (2.30)	
Yes	117	76.7 (2.42)	0	
Satisfied with the amount of current medication education [4)]				0.002
Agree	180	77.6 (2.03)	-5.7 (1.90)	
Not agree, not disagree	112	77.3 (2.41)	-6.1 (2.25)	
Disagree	330	83.3 (1.73)	0	
Use of calculator				<0.0001
Yes	113	86.7 (2.28)	14.7 (2.11)	
No	509	72.1 (1.55)	0	
Grade in mathematics	622	-	3.9 (1.14)	0.0007
Perception of mathematics and medication calculations as easy	622	-	2.7 (1.06)	0.01

Model 100 *R-square = 20.7%

Model F(10, 611)=16.00, p<0.0001

SE: standard error of estimate

5) The adjusted mean is the mean value of the category adjusted for all other determinants in the model.
6) Significance of the determinant.
7) In pair-wise comparisons, the following significant differences between the categories were found: “19-20 y” and “21-25 y” (p=0.009), “19-20 y” and ”26-30 y” (p=0.02), “19-20 y” and “31- y” (p=0.0004).
8) In pair-wise comparisons, the following significant differences between the categories were found: “Agree” and “Disagree” (p=0.008), “Not agree, not disagree” and “Disagree” (p=0.02).

Appendix 15. The independent determinants of decision-making competence (patient vignettes, % of correct answers) (n=622)

Determinant		n	Adjusted mean (SE) [1)]	β (SE)	p [2)]
Semester					<0.0001
	2nd semester	312	53.4 (1.26)	-10.4 (1.56)	
	7th semester	310	63.8 (1.27)	0	
Previous nursing education					0.02
	Diploma degree	131	60.8 (1.71)	4.4 (1.91)	
	No diploma degree	491	56.4 (0.94)	0	
Perception of pharmacology as easy [3)]					0.009
	Agree	109	61.8 (1.93)	3.1 (2.27)	
	Not agree, not disagree	256	55.3 (1.33)	-3.3 (1.74)	
	Disagree	257	58.7 (1.36)	0	
Lack of Regulation		622	-	-2.9 (1.12)	0.009

Model 100 *R-square = 10.2%

Model F(5, 616)=14.06, p<0.0001

SE: standard error of estimate

4) The adjusted mean is the mean value of the category adjusted for all other determinants in the model.
5) Significance of the determinant.
6) In pair-wise comparisons, the following significant differences between categories were found: “Agree” and “Not agree, not disagree” (p=0.01).

Appendix 16. Reliability (Crohnbach alpha) of SUM-scores on instrument [MEI] on content of medication education

SUM-score	**Number of items**	**Crohnbach α**
Basic medication education		
Professional basis of medication management and administration	6	0.89
Theoretical basis of medication management and administration	17	0.92
Administration of medication in different phases of medication process	21	0.95
Promotion of medication safety*	2	(0.77)
Clinical pharmacology		
Heart and vascular diseases	5	0.91
Lung diseases*	2	(0.81)
Gastrointestinal diseases	5	0.87
Endocrinological diseases	4	0.83
Neurological diseases	4	0.87
Psychiatric diseases	5	0.94

*obs. only two items

Appendix 17. Reliability (Crohnbach alpha) of SUM-scores on integrated instruments (MCAF, MCS, MNS, ILS)

SUM-score	**Number of items**	**Crohnbach α**
Active participation on medication education	4	0.70
Self-confidence in medication management	6	0.81
ILS- Self-regulation	5	0.73
ILS - External regulation	5	0.52
ILS – Lack of regulation	4	0.71
Patient vignettes	10	0.72
Medication calculation	10	0.77
Knowledge test	30	0.71